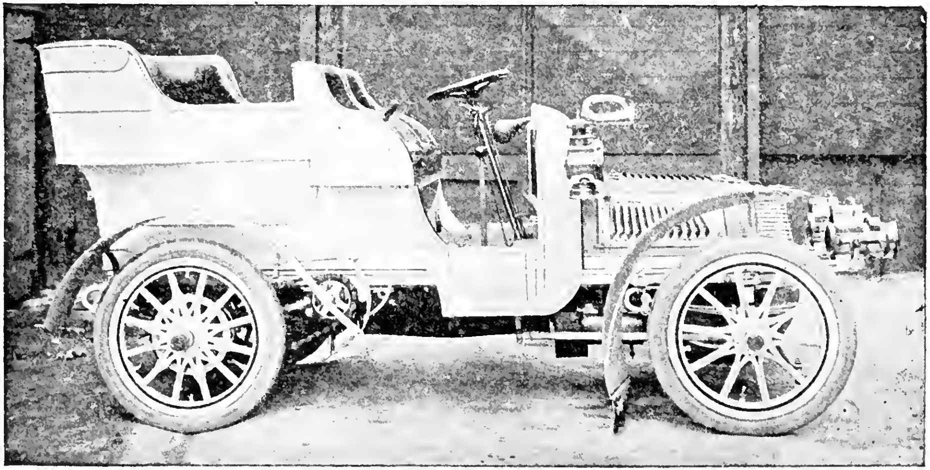

A Modern Motor Car.

THE STORY OF RAPID TRANSIT

BY

BECKLES WILLSON

. WITH THIRTY-SEVEN ILLUSTRATIONS

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PREFACE

It has been said that "when the nineteenth century takes its place with the other centuries in the chronological charts of the future, it will, if it need a symbol, almost inevitably have as that symbol, a steam-engine running upon a railway." *

The characteristic material problem of the nineteenth century was Rapid Transit, and it promises to be one of the most prominent sciences of the twentieth. To it is consecrated to-day more capital, labor, and ingenuity than to all the other sciences together. It is an end to which the greatest inventors and most skilful engineers have consecrated their talents. Whether it be in the form of the railway—steam or electric—the steamship, the telegraph, with or without wires, the telephone, the automobile, ever great and still greater velocity of locomotion or communication is the goal in view. And what victories have been won over the sluggish forces of nature!—what obstacles overcome! The whole story is so modern that, like Electricity and Photography, we can trace its beginnings not further back than the time of our grandsires.

In this story of the rise and progress of the

* H. G. Wells: "Anticipations."

science of Rapid Transit, with its ever new devices, its monuments of engineering, and its billions of capital, there is perceptible a kind of magic. The acceleration from decade to decade since the era of the mail-coaches may here be plainly noted; and the reader will doubtless find the comparison of the actual contemporary time-tables of the journeys between London and Edinburgh, Paris and New York, with those of to-day, a source of interest and information.

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CHAPTER I

BEGINNINGS OF RAPID TRANSIT—THE MAIL-COACH

Economy of time was a virtue but little practised by our ancestors. The innovator who proposed to effect a saving of it was regarded as either a fool or a revolutionary. To a race which lived in the constant prospect of eternity this life at best was but a "fleeting show," and any attempt to multiply its moments was properly frowned upon as vanity.

An idea of seventeenth century celerity may be gained from the fact that in 1609 to send a letter from York to Oxford and obtain a reply required a full month. Even after the establishment of the post in 1660, correspondence was but little expedited. When coaches were introduced it was roundly declared that they would ruin the country; and we find in one chronicler a eulogy of the old wagons of Master Stow's day, which did *not* jog along the highway at a speed of four miles an hour, but traveled easily, "without jolting men's bodies or hurrying them along." The general advantages of rapid transit, on its com-

mercial side, were not even dimly perceived. The new stage-coaches were condemned by the country towns because they would enable London to avail itself of a wider circle of supply and demand, and so injure their trade. In 1673, it took a full week of travel to reach Exeter from London (the fare, by the way, being 40s. in summer and 45s. in winter, which was also the tariff for the journey from the capital to Chester or York). In 1678, six days were required by a six-horse coach to perform the journey between Edinburgh and Glasgow and return. Before the close of the seventeenth century a similar vehicle demanded two days for the journey from London to Cambridge, fifty-seven miles; while another half-century was to elapse before the ordinary journey to Oxford required less time. All traveling was done by daylight: when night journeys were first introduced in 1740, there were many who foreboded ruin to the proprietors on account of the innovation.

One who thought of leaving by coach from Edinburgh for the British capital in the middle of the eighteenth century, planned the journey months in advance, consulted his lawyer and made his will. Such an adventure was not to be embarked upon lightly, as is testified by an advertisement in the *Edinburgh Courant* for 1758, which states that, "with God's permission," the coach would "go in ten days in summer and twelve in winter." This would now suffice to carry a traveler from Edinburgh to Chicago or to Cairo, with two or three days to spare. An idea of what the enterprising projectors meant by a "flying-coach" may be derived from an an-

nouncement in 1765 that such a vehicle, drawn by eight horses, would travel from London to Dover, seventy-one miles, in a single day.

But we must remember that speed in transit was in those early days dependent on something more than the mere will of the coachman or coach-owner. The condition of the roads, not merely in Great Britain but throughout Europe generally, made rapid locomotion impossible. For centuries most of the roads were mere tracks across the face of the country, patched with rude paving in the muddy places and "very noisome and tedious to travel on and dangerous to all passengers and carriages," to quote the statute act for the repair of the highways passed in Mary's reign.

We may say that the first effort in the direction of real improvement dates from the passing of the Turnpike Act in 1633, which premised that portions of the Great North Road leading from the capital to York and Scotland were "very ruinous and become almost impassable, insomuch that it is become very dangerous to all His Majesty's liege people to pass that way." The toll-gate is an institution that began in the reign of Charles II.—the first turnpike toll being erected on the road running from Hertfordshire to the counties of Huntingdon and Cambridge. Travelers, of course, at first resisted the innovation, which was designed for their benefit; improvement was slow and the roads of England and Scotland a century later were but little bettered; indeed, some of them grew worse. We could hardly require better testimony as to their actual condition in 1770 than is furnished by the celebrated Arthur Young

in his "Tour." Speaking of a highway in Lancashire, he declares: "I know not, in the whole range of language, terms sufficiently expressive to describe this infernal road. To look over a map and perceive that it is the principal one, not only to some towns, but even whole counties, one would naturally conclude it to be at least decent; but let me most seriously caution all travelers who may accidentally purpose to travel this terrible county to avoid it as they would the devil, for a thousand to one but they break their necks or their limbs by overthrows or breakings down. They will here meet with ruts which I measured, four feet deep, and floating with mud, only from a wet summer—what, therefore, must it be after a winter? The only mending it receives in places is the tumbling in some loose stones, which serve no other purpose but jolting a carriage in the most unbearable manner. These are not merely opinions, but facts; for I actually passed three carts broken down in these eighteen miles of execrable memory." Young found elsewhere in the north other roads equally bad, where two miles an hour would doubtless have been performed with difficulty.

When the original Government postal system began—with headquarters just out of Eastcheap—the mails between London and Edinburgh took three days. Charles I. having determined in 1635 to mend the dilatory and imperfect communication between the two capitals, established "a running post or two, to run night and day, between Edinburgh and London, to go thither and come back again in six days." With the downfall of the monarchy this service ended, and

in 1649 we find the city of London inaugurating a northern post of its own with a regular staff of runners and postmasters.

The authority of a single postal system managed by the Government was finally settled by an Act passed in 1656. The preamble showed that "the erecting of one General Post Office for the speedy conveying and re-carrying of letters by post to and from all places within England, Scotland, and Ireland, and into several parts beyond the seas, hath been and is the best means, not only to maintain a certain and constant intercourse of trade and commerce between all the said places, to the great benefit of the people of these nations, but also to convey the public despatches, and to discover and prevent many dangerous and wicked designs which have been and are daily contrived against the peace and welfare of this Commonwealth, the intelligence whereof cannot well be communicated but by letter of escript."

In 1658 the first stage-coach between London and Edinburgh was put on the road, setting out once a fortnight, and taking nearly that time in transit. The ordinary method of traveling then, and for centuries, was on horseback or on foot. Coaches had been, it is true, introduced in 1553, but they were little used in the country, where, in fact, the fearful condition of the roads would have restricted their use.

In London and all the other large towns the width of the streets prevented the use of carriages; the Sedan chair, borne by porters, being the polite mode of progression. In Charles I.'s reign horses were occasionally used as bearers.

thus forming the earliest idea of the "Hackney coach."

In 1662 there were only six stage-coaches in the whole kingdom, and even this number was considered by some of the slow-going, conservative citizens as just half-a-dozen too many.

Matters were to be yet worse before they were bettered, for with the establishment of the General Post Office at the Restoration a lower standard of despatch prevailed, and six days, instead of three, were consumed by the mails between London and Edinburgh. Such a retrogression aroused Nottingham, York, and other towns to protest, and as a consequence the King's post became accelerated to "three and a half or four days," which was a rate much slower than that which had prevailed thirty years before. Nevertheless, it must be remembered that the volume

The Earliest Hackney Coach.

of mail business between the two capitals was very scanty, a hint of which truth we may obtain from the fact that, on one occasion in 1745, the mail brought only a single letter from the South—for the British Linen Company. On another day in the same year only one was received in London—for Sir William Pulteney, the banker. With Edinburgh four days from London it was on a par with Constantinople at the present day.

Early in the eighteenth century, when the mails were conveyed on horseback or in light carts, and the robbery of the mail was one of the most common of crimes, the rate of traveling did not often exceed four miles an hour. There is still to be seen a time-bill for the year 1717, addressed "to the several postmasters between London and East Grinstead." It is headed, "Haste, haste, post haste!" from which the casual reader might gather that extraordinary expedition would be observed. The mails, we learn, departed "from the letter-office in London, July 7th, 1717, at half-an-hour past two in the morning," and reached East Grinstead, distant forty-six miles, at half-past three in the afternoon. The rate, including stoppages, was a trifle over four miles an hour. But even in 1766 four miles an hour was regarded as the height of postal celerity. "Letters are conveyed in so short a time, by night as well as by day, that every twenty-four hours the post goes 120 miles, and in five or six days an answer to a letter may be had from a place 300 miles from London." Letters were despatched from London, as well as received, at all hours of the day and night, there being no regularity in the service until 1784.

As a sample of speed in 1734 we may mention that in that year John Dale advertised that a coach would take the road from Edinburgh for London "towards the end of each week, to be performed in nine days, or three days sooner than any coach on the road." Twenty years later the pace, so far from having improved, was worse, inasmuch as it took ten days in summer and twelve in winter, and in 1763, the coach set out, it is stated, once a month, and "took a fortnight, if the weather was favorable." The cause of this degeneracy is doubtless to be found in the practise of post-chaise traveling in parties—by means of which a few travelers shared a vehicle together and secured greater speed and cheapness. A journey to York was regularly done in four days ("if God permit").

In 1742 the Oxford stage-coach left London at seven in the morning and reached Uxbridge at mid-day. It arrived at High Wycombe at five in the evening, resting there for the night, for there was no traveling in the dark hours, and proceeding on at the same rate on the following day.

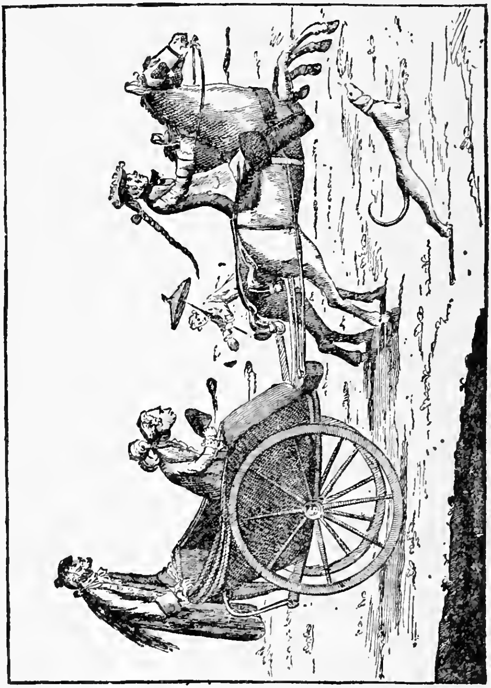
In 1758, however, there came an improvement. Up to that year the Great North Mail set out thrice a week occupying eighty-seven hours in its northward journey and not less than 131 hours on its return south. The cause of the latter excess was the stoppages made at Berwick and Newcastle, ranging from three hours at the former to twenty-four at the latter. An Edinburgh merchant, George Chalmers, a sufferer by these delays, entered into correspondence with the officials, and after pointing out that the stoppages were quite superfluous, induced them to avoid

the old, long route *via* Thorne and York for that by Boroughbridge, thereby shortening the journey by twelve miles. This resulted in the timetable being amended, so that the journey was now achieved in eighty-two hours to and eighty-five from Edinburgh. Furthermore, Chalmers prevailed upon the Government to run the mails six times weekly. The Government recognized Chalmers's services by making him a grant of £600.

It was about the same time (1767) that Henry Homer was congratulating his countrymen on the vast improvements which he had witnessed in his lifetime. To the condition of the roads and the difficulties of internal communication he attributed the backward state of the country in the reign of Queen Anne.

The trade of the kingdom languished for means of rapid transit. "Few People," he says, "cared to encounter the Difficulties which attended the Conveyance of Goods from the Places where they were manufactured to the Markets where they were to be disposed of. . . . The Natural Produce of the Country was with Difficulty circulated to supply the Necessities of those Counties and Trading Towns which wanted, and to dispose of the Superfluity of others which abounded. . . . We are now released," he adds, "from treading the cautious steps of our Forefathers and our very Carriages travel with almost winged expedition between every Town of consequence in the Kingdom and the Metropolis. . . . Despatch, which is the very Life and Soul of Business, becomes daily more attainable by the free Circulation opening in every

Channel what is adapted to it. . . . There never was a more astonishing Revolution accomplished in the internal System of any Country than has been within the Compass of a few years



The Cabriolet

in that of England. Journies of Business are performed with more than double Expedition. Everything wears the face of Dispatch." In Homer's opinion, it was all due to the "Refor-

mation which has been made in our Publick Roads."

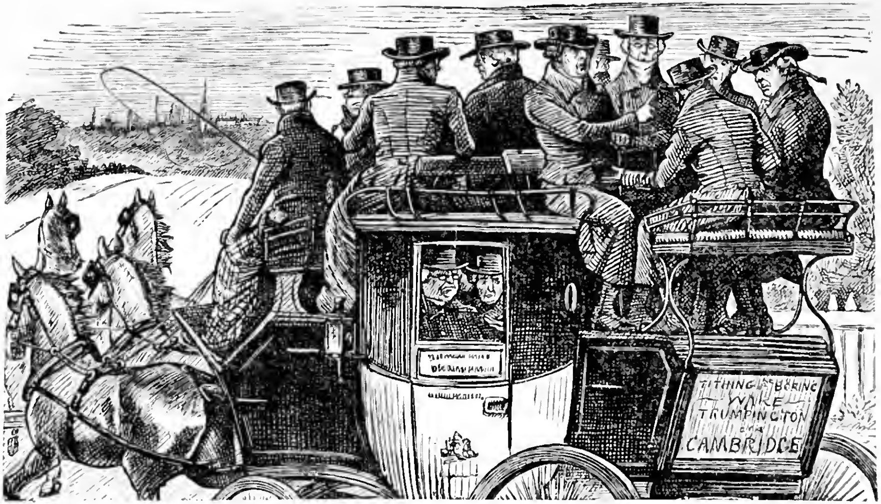
Abroad the roads and means of locomotion were, if anything, behind those of England, the newly introduced cabriolet being a luxury for the rich, and in the more populous districts traveling was usually done on foot or on horseback in company, as described by Defoe toward the end of his "Robinson Crusoe." The journey from Lisbon to Calais by land took two months in winter and five or six weeks in summer.

While these improvements in land carriages were taking place, attention was also being paid to the provision of facilities for carriage by water. Canals were cut to connect various river basins, and in 1758 the idea was revived and finally carried out, of connecting the Forth and the Clyde.

In 1758 Brindly had succeeded in carrying out the Duke of Bridgwater's scheme, and this gave a fresh impetus to canal projects. The Duke was the possessor of immense beds of coal at Worsley, which could not be profitably worked owing to the cost of carriage to Manchester. The canal cut down this cost to a fraction and was the beginning of a network of canals which was soon spread over England. It was the Duke of Bridgwater, who, when asked his opinion of the new tram-roads, declared that they meant "mischief" to the canal-owners.

For those country gentlemen and citizens "of the old school" who did not see any virtue in rapid transit a further mortification was at hand. This was the establishment of the mail-coach system by Palmer in 1784. This celebrated advo-

cate of speed had had his attention drawn to the singular discrepancy between the average traveling rate of the post and of the coaches. Letters which left Bath on Monday night were not delivered in London until two or three o'clock in the afternoon of Wednesday, and sometimes even later; yet the coach which left Bath on Monday afternoon arrived in London early enough for the delivery of parcels by ten o'clock the next morning. Despatch was in many cases of such importance to the Bath tradesmen that, although the postage was only threepence, they willingly paid two shillings to forward their letters to the capital in the form of a coach parcel. Elsewhere Palmer found the same state of affairs. The post which left London on Monday night or early Tuesday morning did not reach Warwick, Worcester, or Birmingham until Wednesday morning; and the Exeter post not until Thursday morning, while letters were five days in passing from London to Glasgow. It was now proposed to alter all this and establish a regular mail-coach service all over the kingdom, a project which met with the utmost opposition from the authorities, who failed to see "why the post should be the swiftest conveyance in England," and regarded the scheme of bringing the Bristol mail to London in sixteen or eighteen hours as "altogether visionary." Nevertheless, Pitt was resolved to allow Palmer's plan to be put into execution, and the first mail-coach left London for Bristol on the evening of August 24, 1784. At the end of a dozen years it was found that the greater part of the mails were conveyed in one-half the previous time; in many cases one-



An Early Stage-coach.

third, and in some of the cross-posts in one-fourth of the previous time.

Although it became apparent after the introduction of railways that the days of the mail-coach system were numbered, yet coaches were not entirely superseded on the great highways for many years. In 1832, according to the London-Edinburgh time-table for that year, the coach left the Post Office at 8 P.M., reached Grantham at 7.23 the following morning, Doncaster at 1.12 P.M., York at 4.54 P.M., Newcastle at 1.50 A.M., and Edinburgh at 2.23 P.M. The whole journey of 397¼ miles was thus made in forty-two hours twenty-three minutes. The "up" mail was somewhat slower, occupying forty-five hours thirty-nine minutes, but both were equally punctual in arrivals and departures *en route*, so that it has been said that the farmers used to set their clocks and watches by the mail-coaches.

Yet high speed was not yet gained. In 1751 it took twenty-four hours to go from London to Dover: thirty years later it could be done in the course of the same day, and in 1802 Lord Campbell tells us that he started from the "White Bear," Piccadilly, at 4 A.M., reaching Dover at 9 P.M., seventeen hours, including an hour's stoppage for dinner at Canterbury.

Porter, in his "Progress of the Nation," states that he "well remembers leaving the town of Gosport (in 1798) at one o'clock of the morning in the *Telegraph*, then considered a fast coach, and arriving at the Golden Cross, Charing Cross, at eight in the evening; thus occupying nineteen hours in traveling eighty miles, being at the rate of rather more than four miles an hour."

In 1798 the Holyhead mail left London at eight at night and arrived in Shrewsbury between ten and eleven the following night, taking twenty-seven hours to run 162 miles. About this time, too, there was a coach on the road between Shrewsbury and Chester known as the *Shrewsbury and Chester Highflyer.* It started from the former town at eight in the morning and arrived at Chester (a distance of forty miles) at the same hour in the evening.

CHAPTER II

THE FIRST RAILWAYS

Speed in locomotion now began to be publicly considered. The performances of the crack mail-coaches were watched with that interest which to-day occasionally attends the journeys of an "ocean greyhound" or an express train to the north.

"It might have been supposed," writes Porter, "that to attain so great a rate of speed as ten miles an hour, the personal safety of passengers would be further endangered, but the very contrary is the fact, so that notwithstanding the rapidity with which we are whirled along, the number of accidents is actually lessened, a result produced by the better construction of the carriages . . . and the superior character of the drivers." *

* "Seated on the old mail-coach," wrote De Quincey, "we needed no evidence out of ourselves to indicate the velocity. We heard our speed, we saw it, we felt it . . and this

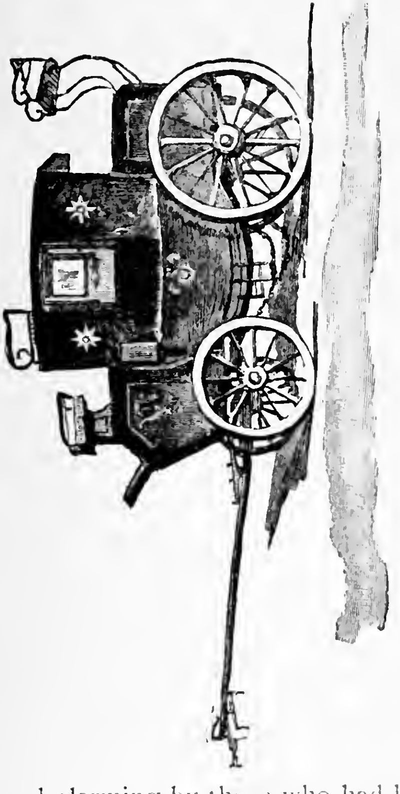
Sportsmen regarded these achievements as affording them exciting entertainment, but the mercantile part of the community were not slow to perceive that the increased speed had a concern for them. Both classes recognized that better roads were necessary: Parliament became aroused, and Telford and Macadam, by their improved methods of road-making, paved the way, literally, for more rapid locomotion. By the use of broken granite, ashes, and burnt clay, hundreds of miles of roads in the kingdom became transformed, and it was not long before it was seen that one horse on a level track could do as much work as four on a common road.

The maximum speed obtainable by the mail-coach on a good road had been reached. When the era of railways dawned there were nearly 3,000 stage-coaches in operation—of which number about half plied out of and into London—and about 100 mail-coaches. In his coach system the Englishman took a natural pride, especially upon comparing it with that of France. In no other country was there such promptitude of arrival and departure, or such a volume of transportation traffic.

For instance, the Edinburgh mail ran 400 miles in forty hours, stoppages included, which was at the rate of nearly eleven miles an hour. A coach to Exeter, the *Herald*, went over its ground, 173 miles, in twenty hours, although the country was hilly; and the Devonport mail per-

speed was not the product of blind insensate agencies, that had no sympathy to give, but was incarnated in the fiery eyeballs of the noblest among brutes, in his dilated nostril, spasmodic muscles and thunder-beating hoofs."

formed its journey, 227 miles, in twenty-two hours. Of course this increase of speed was



Old English Coach—"The Flying Coach."

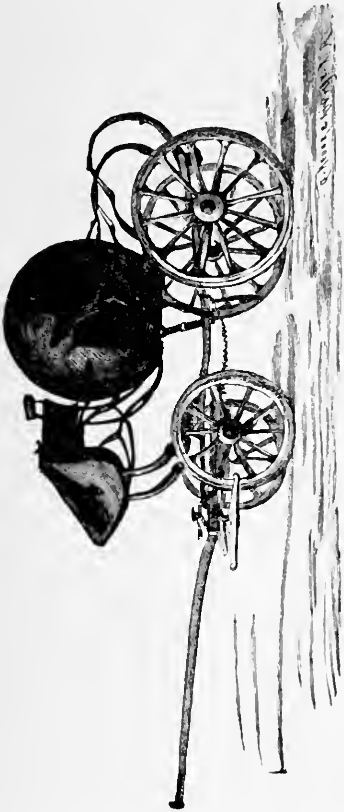
considered alarming by those who had been accustomed to the old-fashioned slow coaches, and

the speed at which the new vehicles traveled was regarded as a menace to human life.

Nevertheless, there were a body of men crying progress, men like Anderson and Gray, who declared that the commercial future of the country depended upon rapid transit, and that if railroads with steam locomotives were employed it would even be possible to attain a velocity of twenty miles an hour. Upon this proposal the utmost ridicule was cast, especially by the *Quarterly Review*, which assured its readers that the people "would as soon suffer themselves to be fired off upon one of Congreve's *ricochet* rockets as trust themselves to the mercy of such a machine (a high-pressure engine) and going at such a rate (eighteen or twenty miles an hour)." Criticizing the project of the London and Woolwich Railroad, the *Quarterly* backed old Father Thames against it for any sum, and expressed the hope that Parliament would "in all railroads it may sanction, limit the speed to eight or nine miles an hour, which is as great as can be ventured upon with safety." Yet at eight or nine miles an hour the cry was still "we move too slowly—unless we can transport our coal and iron—our goods and passengers more quickly, we are giving hostages to fortune and will surely not progress as we ought to progress."

Reflecting upon it now, it seems strange that so obvious an idea as a tram or railway had not occurred to mankind at an earlier period in its history. It probably did, but mankind was not ready for it: there was nothing to be served by an increase of speed. Apparently, few cared to move quickly; with us in the twentieth century

velocity of motion is an end in itself, as witness skating, tobogganing, and the switchback rail-



Globular-shaped Mail-coach, Used in Continental Europe a Century Ago.

way—to say nothing of cycling and motoring, which do lead us somewhere. It is true Dr.

Samuel Johnson extolled the delights of post-chaise traveling at the exciting velocity of ten miles an hour; but celerity of movement seems, even sometimes in warfare, to have been an unimportant and therefore unconsidered factor. Napoleon extended the principle of rapid transit to those armies which astonished Europe about the same time that England was bewildered by the news that a journey between London and Edinburgh could be done in less than two days.

The actual inventor of railways is unknown—most probably the idea was contributed to by many. Roger North mentions a sort of wooden tram-line existing in the neighborhood of Newcastle-on-Tyne prior to 1676. "The manner of the carriage," says he, "is by laying rails of timber from the colliery down to the river exactly straight and parallel; and bulky carts are made with four rowlets fitting these rails, whereby the carriage is so easy that one horse will draw down four or five chaldrons of coal, and is an immense benefit to the coal-merchants."

It was soon discovered that one grave disadvantage attended the use of wood for the construction of the *rails*—its liability to wear. Wherefore, instead of wooden rails, flat iron bars were employed, nailed to the sleepers in the same fashion as the timber rails. This change in construction was found to work well, there being less friction to overcome on the iron than on the wooden rails. In other cases, stone was employed in the construction of these tramways, sometimes to form the rails, but more often the sleepers. A subsequent improvement was made

(in 1789) in the iron rails, by forming what is known as an edge rail. The advantage of this was that neither wheel nor rail became clogged with dirt, a condition inseparable from flat rails.

Dr. James Anderson, late in the eighteenth century, recommended the construction of railways for the purpose of conveying agricultural produce from one part of a farm to another. At a later date he proposed the general extension of railways or tram-roads throughout the kingdom. The carriages were of course to be drawn by horses. "Suppose," said he, writing in 1801, long before the introduction of the steam locomotive, "a railway were brought from the wharfs to Bishopsgate Street, . . . all the wagons to be made of one size and form, each capable of containing one ton of sugar, or other goods of similar gravity. Let the body of each of these wagons be put upon a frame that rests upon the two axles of the four wheels, calculated to move only upon the railway, and let each of these wagons be loaded with goods which are to go to the same warehouse or its vicinity. The whole of the wagons being thus loaded, they are moved forward till they came to the end of the road, at which place they should be made to pass under a crane."

The crane would lift the wagon upon another truck, formed for street use, and when emptied at the close of the day returned to the railway truck, which returns to its point of departure. Anderson believed that this method of distribution, instead of the old and cumbersome carter system, would result in a great saving of money, time, and labor. "The convenience of such

roads would be very great from the circumstance of having separate movable wagons as above stated. One separate wagon or more could be thus left at any place on the road, and others taken up in their stead, like passengers in a stage-coach, without disturbing the others. . . . On the same plan it is certainly very practicable to carry roads of a similar description from London to Bath."

Soon afterward tram-roads or railways began to spread over the face of the country, more especially in the northern counties, but as yet no one contemplated the employment of tram-cars as a substitute for stage-coaches, until about the era that the locomotive engine was invented. The plan just mentioned of a system of railways, the motive power being horses, was never therefore carried out, although so late as 1830, four years after the opening of the Stockton and Darlington Railway, it was proposed to use horse-power on the London and Birmingham Railway, the vehicles being warranted to travel at the rate of eight miles an hour. In 1801 the Surrey Railway obtained an Act for the construction of a tram-road for general merchandise from Wandsworth to Croydon, and the line proved a success, one horse being able to pull more than fifty tons, or fifty times what could be done on an ordinary road.

Soon after this time James Gray, of Nottingham, visiting one of these tramways which connected the mouth of a colliery with the shipping wharf, exclaimed to the engineer of the line: "Why are not these tram-roads laid down all over England, so as to supersede our common

roads and steam-engines employed to convey goods and passengers along them, so as to supersede horse-power?" The man's answer was, "Just propose that to the nation, sir, and see what you will get by it! Why, sir—you will be worried to death for your pains." Notwithstanding, from that moment Gray began to preach the doctrine of tram-roads, locomotives, steam-engines and the superseding of horse-power. "It was his thought by day; it was his dream by night. He talked of it till his friends voted him an intolerable bore. He wrote of it till the reviewers deemed him mad."

Beyond all question the first steam locomotive engine which actually carried passengers on common roads was constructed by an ingenious French mechanic, Nicholas Joseph Cugnot, a native of Lorraine. He was born in 1729, and in his youth served in Germany as a military engineer, publishing several works on military science. After Cugnot's retirement from the army, he was enabled, at the public expense, to build a steam-propelled carriage to run on common roads, which was tried in 1769 in the presence of a number of illustrious personages. It was mounted upon three wheels, the leading wheel being driven by an engine whose two pistons acted upon it alternately. During its first run Cugnot's machine carried four passengers, and traveled at the rate of two and a quarter miles an hour. Another locomotive from which great things were expected was built in 1770, and made several successful trials in the streets of Paris. Unluckily, the machine had the misfortune to meet with an accident; it capsized at

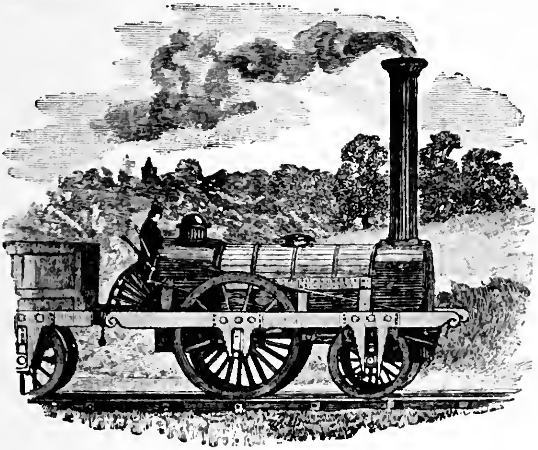
a street corner and was appropriated by the police, who locked it up together with its inventor. Cugnot, however, was quickly released, and long enjoyed a pension from the Government as a reward for his labors.

In England the first practical idea of applying steam-power to wheeled carriages occurred to Dr. Robison, by whom it was communicated to Watt in 1759. Some time subsequently, the latter made a model of a high-pressure locomotive, and described its principle in his fourth patent in 1784, which, among certain improvements, specified "a portable steam-engine and machinery for moving wheel-carriages." His friend, Murdoch, in 1787 made an engine which was employed to drive a small wagon round a room at his house at Redruth in Cornwall. Amongst those who saw it was Richard Trevethick, who in 1802 took out a patent for a similar invention. Symington also exhibited a locomotive in Edinburgh in 1787, and eight years later worked a steam-engine on a line of turnpike-road in Lanarkshire and the adjoining county. The locomotive of Trevethick and Vivian in 1802 ran on the Merthyr tramway, and drew a load of ten tons at the rate of five miles an hour. But one of Trevethick's locomotives blew up—an accident which did much to create distrust of their use.

In the meantime George Stephenson was busy at Killingworth verifying the experiments of other inventors and perfecting his own. In 1816 he patented engines that would travel ten miles an hour without a load.

General discontent with the means of inter-

communication through the country followed on all this agitation, and rendered commerce restless. When Gray published his "Observations on a Railroad for the Whole of Europe," in 1820, he said, "Here is the main-spring of the civilization of the world; all distances shall disappear; people will come here from all parts



One of Stephenson's Passenger Engines.

of the continent without danger and without fatigue; distances will be reduced one-half; companies will be formed; immense capital paid and invested; the system shall extend over all countries; emperors, kings and governors, will be its defenders; and this discovery will be put on a par with that of printing."

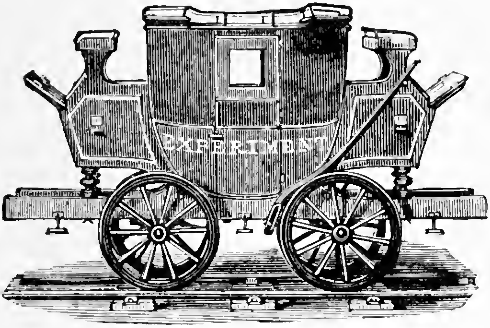
On September 27, 1825, a short public rail-

way, sanctioned after repeated delays by Act of Parliament, was opened between Stockton and Darlington, in the county of Durham, a distance of about eleven miles. By the advice of George Stephenson, who had been appointed engineer of the line, iron rails were substituted for wood, and gradually gaining the confidence of the directors, he prevailed upon them to employ instead of horses, such a locomotive engine as he had recently tried, and with success, at Killingworth Colliery. It was intended, of course, solely for transporting coal, not passengers. The directors, chiefly Quakers, were ridiculed for their decision. "I am sorry to find," said Lord Eldon, "the intelligent people of the North country gone mad on the subject of railways." Another authority observed that he would undertake to "eat all the coals that your railroad will carry." The farmers were told they would be ruined, as there would be no demand for horses. Nevertheless, the bill was carried, the road was built and at the appointed hour, in the presence of a great multitude, "the train moved off at the rate of from ten to twelve miles an hour, with a weight of eighty tons, with one engine—'No. 1'—driven by George Stephenson himself; after it six wagons loaded with coals and flour; then a covered coach, containing directors and proprietors; next twenty-one coal wagons, fitted up for passengers, with which they were crammed; and lastly, six more wagons loaded with coals."

The results of the opening of the Stockton and Darlington line were in some respects surprising. Although the conveyance of passen-

gers had formed no part of the original scheme, yet, on the first day, as we have seen, many hundreds of persons made the excursion, and passengers soon insisted upon being taken regularly. It therefore became necessary to provide carriages adapted to their requirements, and thus began the story of the railway passenger traffic of the world.

The Liverpool and Manchester was the first



The *Experiment*, the First Railway Passenger Coach, 1825.

railway of any magnitude that opened its line for the carriage of passengers. It was opened to the public September 15, 1830, in the presence of the Duke of Wellington and other celebrities, including Mr. Huskisson, who lost his life that day as the result of a melancholy accident. Previous to the opening, the directors, in doubt about what form of traction to employ, offered publicly a premium of £500 for the best locomotive that could, under certain stipulations, be

constructed. It was required of the competing engines:—

1. That they should consume their own smoke.

2. That if they weighed six tons each they should be capable of drawing a train of twenty tons weight at a speed on the level of ten miles an hour.

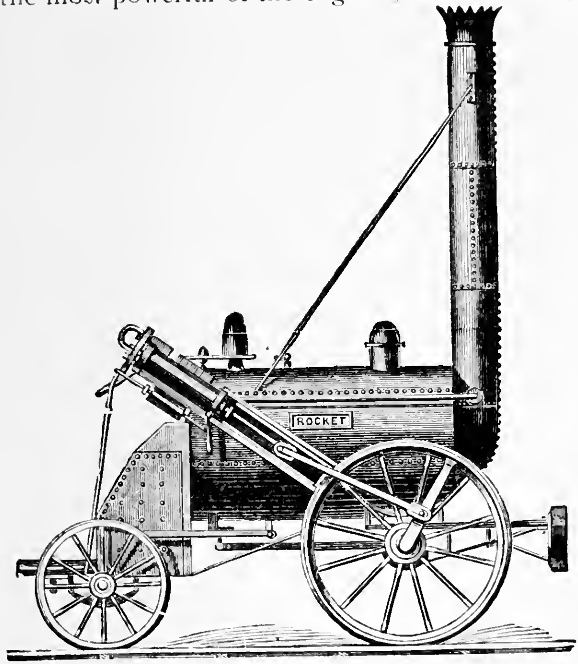
3. That each should have two safety-valves—one beyond the control of the engine-driver.

4. That the height of the engine, including chimney, should not exceed fifteen feet: and lastly, that the price of the engine of the successful competitor should not exceed £550 (which was the sum for which Stephenson had built the Stockton and Darlington engine).

The trial resulted in Stephenson's *Rocket* being declared the winner, the other competitors being the *Novelty* by Braithwaite and Ericson and the *Sans Pareil* by T. Hackworth, both of these, however, suffering unlucky breakdowns. The *Rocket* twice performed the distance of thirty miles: the first time in two hours and a quarter, the second in two hours and seven minutes. Its greatest speed was at the rate of thirty miles an hour, and the average about fourteen.

From that moment a new era in rapid transit began. No one in Europe had ever traveled thirty miles an hour before except in a balloon. Stephenson was forthwith appointed to build the engines of the railway, and from that period until his death conducted the engineering department of what grew to be the London and North-Western Railway.

On September 15, 1830, at the grand opening of the line, the *Northumbrian*, one of the most powerful of the engines, took the lead,

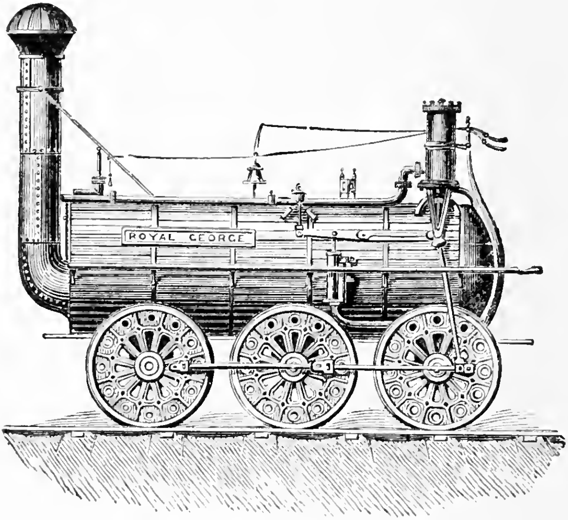


The *Rocket.*

followed by the train of eight locomotives and twenty-eight carriages, which as it rolled proudly onward, deeply impressed the spectators.*

* A local newspaper, describing the event of the opening, when Stephenson himself held the starting lever of the

At Parkhurst, seventeen miles from Manchester, a halt was made to replenish the water tanks, when the accident occurred by which Mr. Huskisson lost his life, a tragic blot on the day's



The *Royal George*

triumph. On the following day the line was thrown open for business. The *Northumbrian* drew a train with 130 passengers from Liverpool to Manchester in one hour and fifty minutes; and before the close of the week six trains

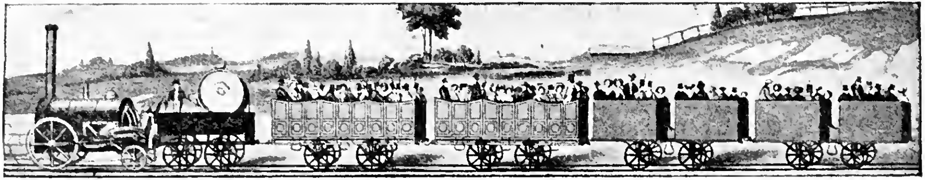
Northumbrian, observed, "The engine started off with this immense train of carriages, and such was its velocity that in some parts the speed was frequently twelve miles an hour."

daily were regularly running. The surprise and excitement already created were further increased when one of the locomotives by itself covered the thirty-one miles in less than an hour.

Of the thirty stage-coaches which had plied between the two towns, all save a single one went off the road soon afterward. The transport of goods and merchandise began in December and furnished new occasion for amazement to the public, for a loaded train weighing eighty tons was drawn by the *Planet* engine at from twelve to sixteen miles an hour. In the following February, 1831, the *Samson* achieved a greater feat, conveying 164½ tons from Liverpool to Manchester in two hours and a half, including stoppages, which would have required seventy horses to perform in twelve hours.

The success of the line rendered obvious the possibilities of the system to the whole world. Branches were soon made to Warrington, to Bolton, and later a junction was effected to Birmingham. Yet when in 1830 the London and Birmingham Company had sought to obtain their charter, a well-known engineer openly deprecated "the ridiculous expectations, or rather professions, of the enthusiastic speculator that we shall see engines traveling at the rate of twelve, sixteen, eighteen or twenty miles an hour. Nothing could do more harm toward their general adoption and improvement than the promulgation of such nonsense." The notion that one hundred miles an hour would one day be achieved would probably have driven this

Liverpool and Manchester Railway—First Class, 1830.



Liverpool and Manchester Railway—Second and Third Class, 1831.

faint-hearted champion of rapid transit into paroxysms of derision.

Early in 1838 a Scottish periodical announced that, before the publication of its next number, in consequence of the despatch of the mails to Warrington by the railway, the inhabitants of Edinburgh would receive their letters and papers a whole day sooner, that is to say, in thirty-one instead of fifty-five hours. A return by post between London and Edinburgh, which in 1818 occupied a week, would now be done in three days and a half. The prophecies of disaster on account of the railway were unfulfilled: instead, everything prospered on their account, even the canal proprietors were amazed to find that railway competition improved their profits, instead of declining them. Even horseflesh increased in value, and yet it had been declared that if railways were to be introduced the stage-coach horses would soon become worthless.

George Stephenson prophesied that it would be cheaper for a working man to ride by rail than to walk, and the prediction has been literally fulfilled in urban districts. As early as 1844, Parliament enacted that passengers should be carried over all lines with moderate speed and comfort at fares not exceeding 1d. a mile. To these parliamentary trains, as they were called, however, the lowest class of passengers were at first rigidly restricted. The speed may be gauged from the fact that the train from Euston to Liverpool, 201¾ miles, started at 7.40 A.M., stopped at every station, and arrived, if punctual, at 6.35 P.M., thus occupying nearly eleven hours

on a journey which passengers, paying the same low fare, can now perform in a little more than four hours.

CHAPTER III

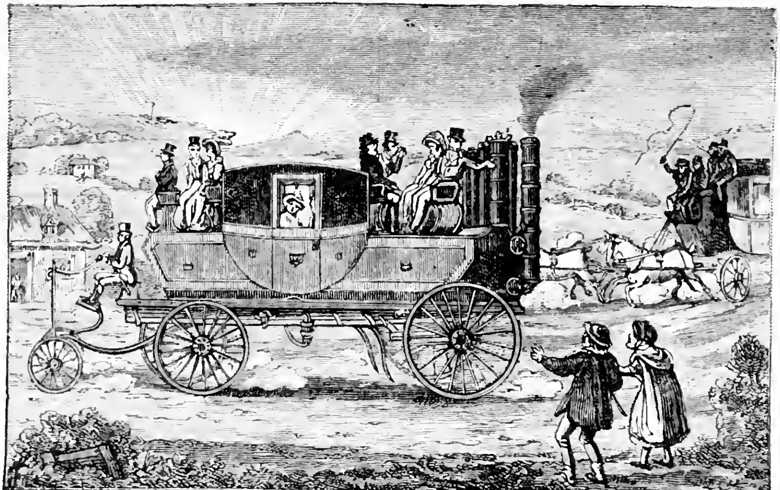
STEAM NAVIGATION

Once the art of navigation had been mastered and the regular trade routes established, the matter of speed was allowed to take care of itself, and even in quite modern times the rate at which ships traveled was an arbitrary one and not of a progressive character. Marco Polo in the twelfth century doubtless traveled as fast as Drake and Raleigh; and the early voyages undertaken by the East India Company to India do not seem to have been materially improved upon by their service in the era of Warren Hastings.*

Rapid transit was occasionally made, even in the old days; and as the eighteenth century wore on and speed came to be more and more considered in commercial circles, regular efforts were made by rival interests to economize time and lessen the number of days and hours *en route*.

But it was not until steam was applied to navigation that speed became a certainty, and, therefore, a necessity of marine traffic, and it

* One voyage, Hastings's return from Calcutta to Plymouth in 1785, was thought remarkable for speed It was done in four months and a half.



Steam *versus* Horses.

grew possible to establish a regular ocean timetable. Yet to demonstrate that even with sailing ships our ancestors did not avail themselves of the utmost advantage, there was the memorable annual ocean race of 15,000 miles run by the China tea-ships within living memory. The London tea-brokers, in order to get the new crop into the market as quickly as possible, used to offer a prize of £500 to the officers and crew of the first tea-laden ship which reached the Thames. In 1866 nine such sailing ships left Foochow between May 29th and June 6th, not very long, ranging from 686 to 853 tons register; but all fast, five being Clyde built, three Aberdeen, and one Liverpool. Every yard of canvas was spread, and they were borne swiftly and steadily by the trade-winds across the ocean, sometimes sighting each other on the way. "It was a wonderful race; for the *Teaking*, *Ariel*, and *Serica* all entered the Thames in one day (September 6th), between 9.45 and 11.30 in the evening, the other six ships being further from the winning-post."*

It is not necessary here to go into the vexed question as to who invented the steamboat, an honor claimed for several rival inventors in several different countries—nor into the early history of that contrivance. We know that as early as 1783, Fitch, an American, propelled a steamboat on the Delaware River by paddles; but the project was soon abandoned. Five years later Patrick Miller, of Edinburgh, fashioned a steamboat which went at the rate of five miles an

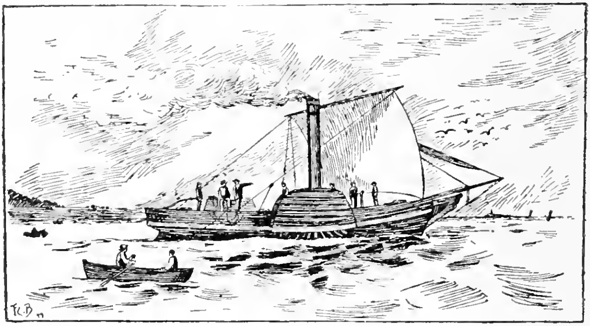
*The course was about 10,000 miles; at the same speed Calcutta would have been reached in eleven weeks.

hour; and in the following year, in conjunction with Symington, built another steamboat, which attained a speed of seven miles an hour, dragging a heavy load. In 1807, Robert Fulton, who had been personally studying the various experiments in Europe, built a steamer, with engines by Boulton & Watt, which made the voyage *up* the Hudson from New York to Albany, a distance of 150 miles, at the rate of five miles an hour, which was regarded as an astounding feat. The first to make a sea-voyage by steam was Stevens, who went in a new steamer from New York to the Delaware; and having introduced many important improvements achieved the unheard-of velocity of thirteen miles an hour on that river. In Europe the pioneer of steamboats for passenger traffic was Bell's *Comet*, which began to ply regularly between Glasgow and Helensburgh in 1812. In the following year steamers appeared on the Clyde, the Severn, and the Thames, and in a few years steam navigation was firmly established, not only in Great Britain but in Continental countries.

The innovation of steam soon entirely revolutionized river and channel traffic. Whereas, before 1813, shipping had been entirely dependent on the wind, it was now possible to travel at the rate of nine miles an hour in a dead calm and seven in moderately boisterous weather, as well as to carry goods and passengers at one-third the charge exacted by land transit. In 1821 they first carried the mails between Dublin and Holyhead and between Calais and Dover.

When it was first proposed to cross the At-

lantic from England solely by steam-power, the project was regarded with suspicion, notwithstanding all that had been thus early accomplished by steam. A number of the most eminent scientific men recorded their opposition to it, and its failure was freely prophesied even by those who believed in the future of land traction by steam. The distance to be traversed



The *Comet.*

was at least 3,000 miles of open ocean, with no intervening land where a vessel might put in for shelter and supplies. It is true that in 1819 a vessel named the *Savannah*, of 350 tons, had made the journey from New York to Liverpool in twenty-six days; but this vessel had used sails as well as steam, and was, besides, a week longer on the voyage than the sailing "liners." The quantity of coal necessary to propel a steamer with engine of 300 horse-power across the Atlantic would, it was estimated, be two tons for each horse-power of the engine—or, say, 700 tons altogether, including provision for

accident or delay. There could not possibly be room for so much fuel; if the tonnage of the vessel were made more than four times its horsepower, the latter would be inadequate to its propulsion at the ordinary rate of steamships.

The first ship actually to steam across the Atlantic was a Canadian—the *Royal William*, launched at Quebec, 1831, her engines being sent from England. In 1833 she went from Pictou, N. S., to Gravesend, arriving September 11th, after twenty-two days' passage. But this feat attracted little attention, although it no doubt contributed largely to the result so soon to be attained.

In 1836 a series of "liners" accomplished the voyage from New York to London in about twenty days, but owing to the Atlantic currents this time was usually increased to thirty-six days on the voyage from London to New York. Mercantile considerations demanded an improvement in the speed of communication between the Old World and the New.

If the regular navigation of the Atlantic by steam were practicable, it was essential to all interests that it should forthwith be adopted. Nothing is so important in extensive commercial transactions as early and regular intelligence and a quick and speedy transmission of orders and goods. From what steamers had already done, it was urged that is was reasonable to expect that they would cross the Atlantic in half the time occupied by the old liners. New York would therefore be brought within a ten or fourteen days' voyage from London, Bristol, or Liverpool. Moreover the arrival of advices

could be circulated with certainty to a day, if not to an hour—and the effect of this certainty and punctuality would have a wide-spread influence in every department of trade.

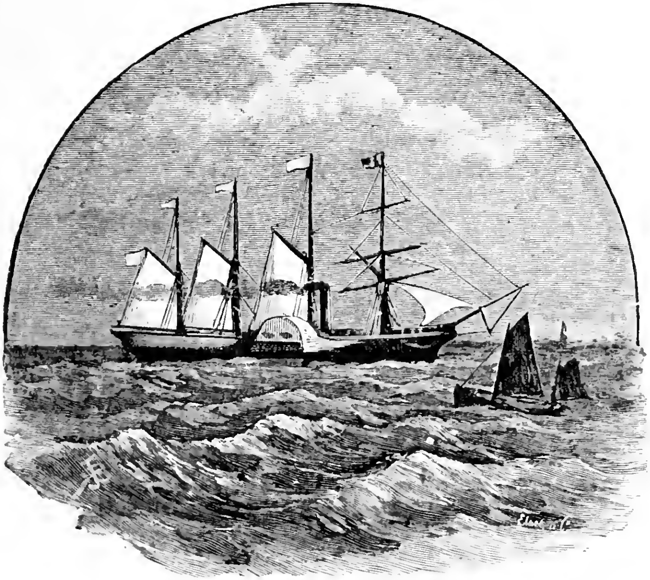
The *Great Western*, a steamship of 1,200 tons, which was to make the experiment, left Bristol on April 8, 1838, for New York, having on board 660 tons of coal and seven adventurous passengers.

Three days before, the owners of the *Sirius*, a much smaller vessel, built to ply between London and Cork, had despatched her for the same destination. Thus there ensued a struggle between the two steamers, for the credit of being the first to traverse the entire breadth of the wild Atlantic. The *Sirius*, which had the start by some days, or 400 miles, made little way comparatively the first week. She carried more weight in proportion than the *Great Western;* but as her coal was consumed, she made much better running. For instance, during the first week out, her daily run never exceeded 136 miles; on the second day indeed it was only 89. On the other hand the *Great Western* accomplished ten miles an hour during the second day, and her average daily run for the whole voyage was 211 miles. At this rate she would soon overtake her rival; but as the *Sirius* got lighter she made greater speed. On the fourteenth day she ran 218 miles, equaling the *Great Western*, and on the twenty-second ran only three miles less than her larger competitor.

But although it was a close race, the *Sirius*, by reason of her start, was the winner, arriving in New York on the morning of the 23d. The

Great Western steamed in the same afternoon amidst the greatest excitement—flags flying, guns firing, and bells ringing.

Ten to fifteen days had thus been knocked off



The *Great Western.*

the westward Atlantic journey. Never before had a voyage to the New World been done in fifteen days. The first, by Columbus, had taken five weeks.*

* *I.e.* from the Canaries to St. Kitts. The probable distance run between Gomera and the newly discovered island was 3,105 miles. The longest daily run was 200 miles.

The *Sirius* proved too small for continued Atlantic navigation, and was soon withdrawn to follow her original route between Cork and London, and was afterward lost off the Irish coast. But the *Great Western* continued to ply regularly and successfully, making in the course of the next six years thirty-five voyages. The average distance steamed each voyage was nearly 3,500 miles; the average time occupied in going to New York was fifteen days, twelve hours, and in returning, thirteen days, nine hours.

In 1845 the *Great Britain* reduced the time of the voyage nearly one day to New York, but in the meantime the record time for crossing the Atlantic had been achieved by a Canadian, in a ship the same size as the *Great Western*. In 1838, closely following upon the success of the latter ship and the *Sirius*, the English Government advertised for tenders for carrying the ocean mails. Eventually it was arranged that Samuel Cunard, of Halifax, Nova Scotia, should receive £65,000 per annum for seven years for conveying the mails twice each month between Liverpool, Halifax, Quebec, and Boston. In pursuance of this contract, the steamer *Britannia* left Liverpool July 4, 1840, and arrived at Halifax in twelve days ten hours, the voyage home being performed in ten days.

This was the foundation of the famous Cunard Line. The speed and regularity with which the mails were carried evoked general admiration. The vessels were looked for and usually arrived on the appointed day, and a journey which was made with daring and just apprehensions a few

decades back was soon reduced to a brief episode lasting from nine to eleven days.

In 1849 the average length of passage from Liverpool to Halifax was 11 days, 3 hours; from Halifax to Liverpool, 9 days, 21 hours; Halifax to Boston, 34 hours; Halifax to New York, 55 hours; New York to Halifax, 62 hours; and Boston to Halifax, 41 hours. These returns show a marked increase in speed over the early voyage of steamers across the Atlantic.

But still although the transit across the ocean had been rendered more rapid, the time of the voyage between Liverpool and New York had not been materially reduced.

The steamers of the Cunard Line were, however, soon to have competitors. Soon after they began to ply direct to the commercial capital of the United States a fleet of five American steamers, one after another, appeared to contest with them the "blue ribbon of the Atlantic." The first ship of the Collins Line, called the *Atlantic*, sailed from New York on April 27, 1850. As the time of her expected arrival at Liverpool drew near, the public interest became intense, and it was realized that a rivalry had begun that would make of the ocean a gigantic racecourse for the ships of the two nations. But "the prizes of the turf are paltry compared with that for which these steamers contended—the proud distinction of establishing the most speedy and safe communication between two great continents and two mighty nations!"

At length when the steamers of the Cunard Line began to ply direct to New York the rate of speed began to increase. With the splendid

new ships which were built every appliance which could insure speed was tried. In 1862 with the *Scotia*, then the fastest and largest of the Atlantic fleet, the run from New York to Liverpool was made within nine days.

This feat was regarded as the acme of speed in ocean traveling. "Faster than this," wrote one great authority, "it would be neither safe nor desirable to go—if, indeed, such velocity ever became possible."

The superiority, however, was not distinctly shown by either side. The fastest western passage in 1850 was made by the *Pacific* in September, when only ten days, five hours were consumed between Liverpool and New York; while the swiftest eastern voyage was that of the *Asia* in ten and a half days.

In the meantime, the screw principle had been developed. The *Propeller*, which entered the Mersey in 1840, being the first large steamer to dispense entirely with side paddles, and not long afterward all the vessels of the Inman Line were equipped with screws. After the failure of the Collins Line, this company obtained the mail contract between Liverpool and New York.

On August 16, 1825, the steamer *Enterprise* left Falmouth for Calcutta. She arrived at the Cape on October 13th, and at Calcutta December 9th, having been nearly four months on the voyage, which was about the usual time of a sailing vessel. This was found unsatisfactory: but although shorter routes to India could be found, there was none which was to be entirely traversed by a single vessel. The expedient was therefore resolved upon to break the voyage in

half—and have it performed by two sets of steamers. At the eastern extremity of the Mediterranean a steamship would be within a few miles of a sea which formed an unbroken water route to the far East. The obstacle was the Isthmus of Suez. Several experiments were undertaken by the British Government, and in 1837 the route *via* Alexandria, Cairo, and Suez, comprising a land transit of eighty-four miles was adopted. The British Government undertook the transportation between England and Egypt, and the East India Company between Egypt and India. The mails were sent from Falmouth to Gibraltar in vessels engaged in the postal service with Portugal and Spain; at Gibraltar they were transferred to Admiralty steamers which conveyed them to Malta and Alexandria; they were then carried up the Nile to Cairo, and from thence across the desert to Suez, where a steamer belonging to the East India Company was in waiting to convey them to Bombay.

The time occupied by the old all-sea route was one hundred days; communication with India *via* Suez was now reduced to between fifty and sixty days.

Even yet the community was not satisfied. In order to reduce this time still further, a treaty was made in 1839 with the French Government to convey a portion of the mails through France to Marseilles, whence they were forwarded to Malta, where the steamer from Gibraltar was met. By this expedient two more days were saved.

Prior to 1837, the mails between Falmouth

and Gibraltar rom eighteen to twenty-one days in transit, the vessels calling at Vigo, Oporto, Lisbon, and Cadiz. In that year the British Government entered into a contract with the "Peninsula Steam Company" and soon their steamers were conveying the ..is in five days. Desiring still further t celerate the mail service to India, a furthe.. .rrangement was made in 1840 with this company to run from England to Alexandria, calling only at Gibraltar and Malta, and by this means communication to Suez was made almost as rapid as through France.

When, in the course c or three years, the transit to Suez was ren d swift and regular, it was natural that communication on the other side of the isthmus should be extended and accelerated. A contract was therefore made with the Company—known thereafter as the "Peninsular and Oriental"—by which Calcutta, Madras, Ceylon, and China were embraced within the scope of the service. They began in 1845 with three steamers, the *Bentinck*, *Hindustan*, and *Precursor*, of about 2,000 tons and 500 horsepower. Ocean steaming was so far developed in 1850 that mails were delivered at Hong-Kong containing letters which only fifty-five days before had been written in New York. This performance, which so astounded our sires, and was even a matter of wonderment in the early seventies, is rendered more significant when we remember that these letters after crossing the Atlantic had passed through Liverpool, London, Paris, Marseilles, Malta, Alexandria, and Cairo to Suez, where they were placed on board the

P. and O. steamer, which them down the Red Sea and across the Indian Ocean to Ceylon, where they were transferred to another steamer and by her conveyed, after calling at Penang and Singapore to their ultimate destination. The whole journey was equal in length to half the circumference of the globe.*

In 1851 the steamer for Alexandria sailed from Southampton on the 20th of each month, arrived at Gibraltar on the 26th, at Malta on the 1st of the following month, and at Alexandria on the 9th. A small steamer conveyed passengers and mails up the Nile and in vans across the desert (the railway being built at that time). On the 10th the steamer left Suez, steaming down the Red Sea to Aden. Calcutta was reached in about twenty-eight days from Suez—or seven weeks from Southampton.

But although this velocity caused the utmost admiration throughout Europe, the next few years were to bring about great further changes and improvement. Many important circumstances were to influence and expand the Eastern traffic, principal among which was the assumption by the Imperial Government of the powers of the East India Company; the growth of a gigantic trade with the free ports of China and Japan; the great increase of import and export trade consequent on the Australian gold discoveries; the reduction of letter postage and the establishment of book-post; healthy steamship competition; and the construction of a railway across the isthmus from Alexandria to Suez.

* Even now the journey to Hong-Kong consumes forty-five days by the all-sea route.

In 1866 the P. and O. Company were bound by contract to convey the mails between Southampton and Alexandria in 310 hours; Marseilles and Alexandria, 155 hours; Suez to Calcutta, 499 hours; Bombay to Hong-Kong, 413 hours; Hong-Kong to Shanghai, 84 hours; and Suez and Bombay, 312 hours. A few hours' grace was allowed in each case, but anything beyond twenty-four hours involved a forfeit of £50 a day; whereas, to anticipate the delivery of the mails entitled them to a premium of £25 a day.

Thus we see that the voyage by sea from Southampton to Alexandria had been reduced from nineteen days in 1850 to less than thirteen days in 1866; while from Suez to Calcutta could now be done in just under three weeks. By traveling by rail, however, to Marseilles (thirty-two hours), Alexandria could be reached in six days, eleven hours from Marseilles.

Then in 1871 came the Mont Cenis tunnel, which placed unbroken communication by rail at the disposal of France and Italy. This resulted in the despatch of mails overland to Brindisi, and thence conveyed by steamers to Alexandria.

The great advantage of the Suez Canal is the enormous decrease in the distance to be traveled between Europe and India, and consequent enormous saving of time. It is about 10,719 miles from London or Hamburg, by the Cape of Good Hope, to Bombay. By the Suez Canal this was reduced to 6,274. From Marseilles to Bombay *via* the Cape, the distance is 10,560 miles; by the Suez it is only 4,620.

Yet the passage through the Suez Canal itself

has been materially cut down. The average transit in 1886 was fifty-four hours, and is now only eighteen hours at night, owing to the aid of electric light displayed from the decks of the ships. The average passage of steamers passing by day is about twenty-eight hours. No ship is allowed to exceed five or six knots an hour; so that if the canal were wider the ninety miles could be done in less than half the time.

The value of the British possessions in the West Indies and the importance of the South American trade foreshadowed the establishment of speedy communication in that quarter. Prior to 1840 the best sailing vessels took four weeks to Barbados and Demerara, although the distance was only about 4,000 miles in a direct line. By the establishment of the Royal Mail Steam-Packet Company in 1840, a fleet of fourteen steamers was built to sail twice every month to the West Indies, St. Thomas being the chief rendezvous. The run from Southampton to St. Thomas was done regularly in eighteen days. Ten years later this was cut down to fifteen days.

In 1865 the Royal Mail steamer left Southampton on the 9th of each month, got to Lisbon on the 14th, St. Vincent (Cape Verd) on the 22d, crossed the Atlantic, reached Pernambuco on the 30th; thence to Bahia on the 2d of the following month, to Rio de Janeiro on the 5th—twenty-six days after leaving England. At Rio a branch steamer was ready to convey the mails further south, arriving at Montevideo on the 14th, to Buenos Ayres on the 15th. This journey to Rio has since been cut down to twenty-one days and Montevideo can be reached in twenty-five days

from London. With still faster steamers it could be done in a fortnight.

In 1866 a line of steamers was established to do the distance between California and the Sandwich Islands in about eight days. It has since been done in six days.

The subsequent general adoption of the surface-condenser and the circular multi-tubular boiler enabled higher pressures of steam to be safely carried and economically employed. By 1877, we may say, steamers had been established on all the longer routes and worked at high rates of speed. In that year the Orient Steam Navigation Company began a series of fortnightly sailings to Australia, one of their steamers, the *Orient*, astonishing the world by making the passage from Plymouth to Adelaide, *via* Suez Canal, in thirty-five days, sixteen hours, and the same voyage *via* the Cape, in thirty-four days, one hour, steaming time. It was when the Australian liner *Aberdeen* was built in 1881 that the merits of the triple-expansion type of engine, now so universal, were first conclusively shown. The engines of this vessel worked with a boiler pressure of 125 lbs. per square inch, and expansion took place in three cylinders. Her first voyage from Plymouth to Melbourne occupied forty-two days. In 1883 a New Zealand line was instituted, and voyages from England thence cut down from sixty-five to thirty-seven or forty days.

But it was and is on the Atlantic that the greatest ocean speed triumphs have been won. In 1874 the White Star liners *Britannic* and *Germanic* were built at Belfast, and from that year a hotly waged contest for superiority in speed,

size, and equipment has lasted to the present day. Each increase in speed nowadays represents innumerable modifications—some minor, some radical—which engineering and shipbuilding science suggests. For a time the White Star liners maintained first place for speed, until they were ousted by the Inman liner, *City of Berlin*, which beat the *Britannic's* record of eight and a quarter days across the Atlantic. Liner after liner appeared, each faster than its predecessor, until in 1886 the average time between Sandy Hook and Queenstown was about six days, fifteen hours, as compared with eleven days, nineteen hours in 1856. Since then the record has been lowered repeatedly. The *Campania* achieved the journey in five days, twelve hours, fifteen minutes, which was supposed to be unsurpassable until it was broken first by one ocean greyhound and then another, the *Lucania* in 1894 doing the voyage in five days, eight hours from Queenstown to New York.

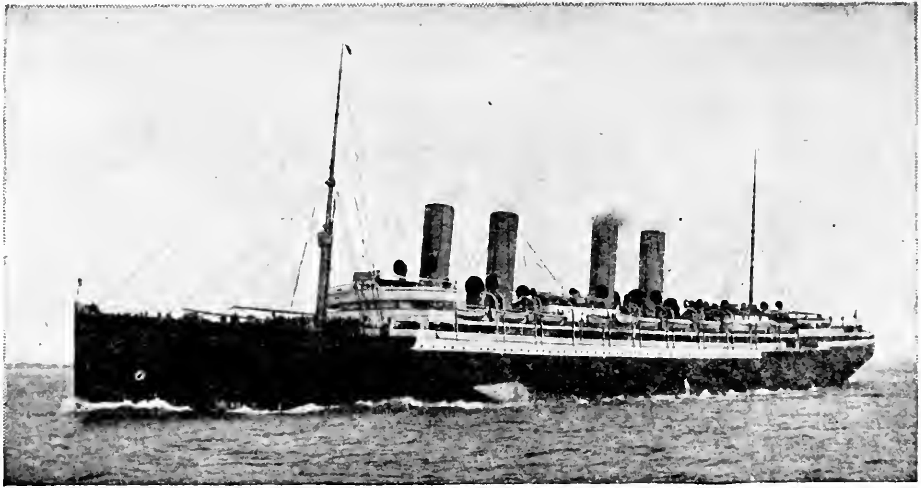
The *Lucania's* record of 562 knots in a single day was soon to be beaten by the great North German Lloyd steamers sailing from Southampton to New York, one of which, the *Fürst Bismarck*, had already done this longer journey in less than six and a half days.

In July, 1901, the *Deutschland* lowered all records by crossing the Atlantic in five days, eleven hours, five minutes, her average speed being 23.51 knots, whilst the best day's run was 557 miles. The distance traversed between Sandy Hook and the Eddystone on that occasion was 3,082 miles. In June, 1902, the *Kronprinz Wilhelm* maintained a trifle higher average speed

than the *Deutschland's* record. As a matter of fact, the length of the voyage between New York and Plymouth was not reduced, as the *Kronprinz* was five days, eleven hours, thirty-two minutes running between Sandy Hook and the Eddystone, twenty-seven minutes longer than the *Deutschland*, but in those few minutes she steamed an additional thirteen miles, the log of the *Kronprinz* showing that the total distance traveled was 3,095 miles. Thus, although the *Kronprinz* established a new record for average speed, the *Deutschland's* 557 miles remained the best day's run on the homeward voyage. The *Kronprinz's* average speed throughout her trip was 23.53 knots.

In 1901 the new twin-screw steamer *Arundel* made a record channel passage from New Haven to Dieppe in two hours, fifty-eight minutes, or at an average speed of twenty-two knots. The absence of all vibration was secured to passengers by a patent balancing arrangement of the machinery.

What part electric traction will play in the future of navigation cannot easily be predicted. But even with steam, it is almost certain that the old piston and cylinder type of engine will be superseded. Another and fundamentally different type—the turbine—in which the impulse of the steam spins a wheel instead of pushing a piston—is making great headway. The antiquity of the idea is considerable—it is even ascribed to Hero of Alexandria, who describes an elementary form of such an engine, and this rotary principle was certainly experimented with and abandoned by the seventeenth century experimenters. The



The *Deutschland.*

reason was that it was not adapted to pumping, this being the end then, and until toward the close of the eighteenth century, in view. In the meantime the piston-engine became developed and the turbine principle rested dormant until only some twenty years ago the requirements of the dynamo-electric machine opened up fresh inducements for development. By 1894 so many details had been worked out, that capital was induced to venture upon the construction of an experimental ship. This vessel, the *Turbinia*, after repeated trials and modifications, achieved the unprecedented speed of 34½ knots an hour. This was the high-water mark of marine traveling—but it was to be surpassed. The *Viper*, a larger but similar vessel, constructed for the British Navy, as a torpedo destroyer, reached a velocity of forty-one miles an hour. The builder has stated his confidence that fifty and even sixty miles an hour will yet be achieved by such craft on the high seas.

CHAPTER IV

DEVELOPMENT OF THE RAILWAY

It was to be expected that foreign countries would eagerly avail themselves of the extraordinary advantages which railways had been shown to confer upon commerce and society in Great Britain.

But the neighboring kingdom of France was very backward. English visitors to that country in 1845 were wont to complain of the slow pace

of the *diligence*, not remembering that it was quite equal to that which at the beginning of the century was ordinarily accomplished in England.

Posting in Germany was soon, after the downfall of Napoleon, placed on a much improved footing in the matter of speed: but even in 1840 from fourteen to eighteen German miles was reckoned as the ordinary extent of a day's journey.

"France," observes a writer in 1844, "has allowed herself to be outstripped by her neighbors, not only by England, but also by Belgium, Prussia, and Austria, in these means of extending national resources and civilization, which the country more especially stands in need of. She has, however, for the present laid out her money in fortifications, and has little to spare for lines of communication. This, however, is not the sole reason; it lies in the want of confidence between man and man, and in the absence of the spirit of association, by means of which all great public works are executed in England by private enterprise, but which does not exist in France." Yet even at this time the use of steam in navigation was very general in France. All the great rivers being traversed by steamers. "In almost all cases," we read, "the engineers employed on these vessels are Englishmen."

Railway progress in France was certainly slow: and for some years lagged behind England, Belgium, and Germany. Although the introduction of the first tram-road dates from 1783, it was not until 1835 that the first modern railway was begun by the authorization of the line from Paris to St. Germain, its completion following two

years later. In 1838 the Orleans line was undertaken and the railway from Paris to Rouen was opened in May, 1843, and soon afterward extended to Havre. Comprehensive measures at last followed on the part of the French Government, which proposed to form railways from the capital to all the frontiers of France, taking the principal towns and cities *en route*. By 1865 the plan was practically carried out, and between 8,000 and 9,000 miles were open for traffic.

In Belgium, preparations for railways began in 1834, and thirty years later the network was nearly as close and intricate as in Great Britain. Germany early permitted railways to cross her frontiers, and soon numerous lines were stretching far and wide throughout the Empire. Iron highways also began to be projected and built in Italy and Russia, Holland, Sweden, and the other European states. In Spain in 1851 there were only two railways, one of eighteen miles from Barcelona to Mataro; another forty-five miles, from Madrid to Aranjuez. It took some time to conquer the national aversion to rapid transit, and journeys were still made throughout the Peninsula at the speed with which the immortal Gil Blas traveled from Madrid to Alcantara.

The first line in Spain was inaugurated with the ceremony of "blessing the engine" by the Cardinal Archbishop of Toledo, in presence of the Court, Cortes, distinguished nobles, troops and halberdiers, and three miles of spectators. The following day the peasants on the road, seeing the trains traveling at the unheard-of velocity of fifteen miles an hour, involuntarily fell on their knees and crossed themselves until the monster

Great Western Railway.

LONDON TO MAIDENHEAD.

a d 1839

On and after the 1st of May, the SOUTHALL STATION will be opened
For Passengers and Parcels.

An Extra Train to Slough will leave Paddington on **Sunday Mornings, at half-past 9 o'clock,** calling at Ealing, Hanwell, Southall and West Drayton.

Horses and Carriages, being at the Paddington or Maidenhead Station ten minutes before the departure of a Train, will be conveyed upon this Railway.

Charge for 4-wheel Carriage, 12s. Two-wheel ditto, 8s. For 1 Horse, 10s. Pair of Horses, 16s

Post Horses are kept in readiness both at Paddington and Maidenhead, and upon sufficient notice being given at Paddington, or at the Bull and Mouth Office, St. Martin's-le Grand, would be sent to bring Carriages from any part of London to the station, at a moderate charge.

TRAINS.

From Paddington To Maidenhead.

8 o'clock morn. calling at - Southall and Slough
9 do. - - - Slough
10 do. - West Drayton and Slough
12 do. - West Drayton and Slough
2 o'clock afternoon - West Drayton and Slough
4 do. - - - Slough
5 do. - - Hanwell and Slough
6 o'clock evening Ealing, West Drayton and Slough
7 do. - - Southall and Slough
8 do. - - - Slough

From Maidenhead To Paddington.

6 o'clock morning, calling at - - Slough
(and on Wednesday Morning at Southall)
8 do. - Slough and West Drayton
9 do. - Slough and West Drayton
10 do. - - Slough and Southall
12 do. - Slough and West Drayton
2 o'clock afternoon - - Slough and Southall
4 do. - - - Slough
5 do. - - Slough and Hanwell
6 o'clock evening - Slough and West Drayton
7 do. - - Slough and Ealing

The six o'clock up Train will call at Southall on Wednesday mornings, for the convenience of persons attending the market on that day.

SHORT TRAINS.

From Paddington To West Drayton.

past 9 o'clock Morning, past 1 do. Afternoon, past 4 do. do., past 8 do. Evening, calling at Ealing, Hanwell, and Southall.

From West Drayton To Paddington.

before 9 o'Clock Morning, before 11 do., before 3 Afternoon, before 7 o'Clock Evening, calling at Southall, Hanwell, and Ealing.

☞ *There are no second class close carriages in the short Trains.*

Passengers and Parcels for Slough and Maidenhead will be conveyed from all the stations by means of the short trains, waiting to be taken on by the succeeding long Train, as above; and in like manner they will be conveyed from Maidenhead and Slough, to every station on the Line.

On SUNDAYS.

From Paddington To Maidenhead.

8 o'clock Morn. calling at - - Ealing and Slough
½ past 8 do. do. - West Drayton and Slough
9 do. do. - - Southall and Slough
5 afternoon do. Hanwell West Drayton and Slough
6 evening do. Ealing West Drayton and Slough
7 do. do. - - Southall and Slough

From Maidenhead To Paddington.

6 o'clock morn calling at - - - - Slough
8 do. do. - Slough Southall and Ealing
9 do. do. Slough West Drayton and Hanwell
5 afternoon do. - - Slough and Hanwell
6 evening do. - - Slough and West Drayton
7 do. do. - - - Slough and Ealing

SHORT TRAINS.

PADDINGTON TO SLOUGH.

Half-past Nine o'Clock Morning, - - - calling at Ealing, Hanwell, Southall, and Drayton.

To West Drayton.

past 9 o'Clock Morning, calling at *Ealing, Hanwell, & Southall, and proceeding to Slough*
past 8 do. Evening. *Ealing, Hanwell & Southall*

From West Drayton.

before 8 o'Clock Morning, before 7 do. Evening, calling at *Southall, Hanwell & Ealing.*

FARES.

Paddington.	1st. Class Coach.		Second Class. Close		Second Class. Open		Maidenhead.	1st. Class Coach.		Second Class. Close		Second Class. Open	
To Ealing	1	6	1	0	0	9	*To Slough*	2	0	1	6	1	0
Hanwell ...	2	0	1	6	1	0	*West Drayton*	3	0	2	6	2	0
Southall	2	6	1	9	1	3	*Southall*	4	0	3	0	2	6
West Drayton	3	6	2	0	1	6	*Hanwell* ...	4	6	3	6	3	0
Slough	4	6	3	0	2	6	*Ealing*	5	0	4	0	3	6
Maidenhead.	5	6	4	0	3	6	*Paddington.*	5	6	4	0	3	6

The same Fares will be charged from Slough to West Drayton as from Maidenhead to Slough.

Omnibuses and Coaches start from Princes Street, Bank, one hour before the departure of each Train, calling at the Angel Inn, Islington; Bull Inn, Holborn; Moore's Green Man and Still, Oxford Street; Golden Cross, Charing Cross; Chaplin's General Office, Regent Circus; and Gloucester Warehouse, Oxford Street; to the Paddington station.—**Fare 6d.** without

Facsimile Time-table, 1839.

was out of sight. This speed was not, however, regularly maintained; twelve miles an hour was for a long time the standard schedule time on the Spanish railways.

But let us return to England just before the general employment of railways.

In 1837 it was necessary in order to proceed to Dover by the most expeditious public conveyance to book seats in the *Foreign Mail*, which left the General Post Office in St. Martin's le Grand every Tuesday and Friday night and arrived in Dover in time for the packets at 8.15 the following morning—thus beating by half an hour any other coach on the road.

For day travel, the *Express* started from the "Golden Cross," Charing Cross, at 10 A.M. each morning, doing the journey in nine hours, as did the *Union Coach*. The others took longer. The famous *Tally-ho* coach between London and Canterbury left town every afternoon and accomplished the fifty-nine miles in five hours and a half.

Laws were actually passed in England, on the first introduction of steam on railways, limiting the pressure in the engine-boilers to thirty pounds per square inch. The first railroad charter contained a clause limiting the speed of trains to twelve miles an hour, and when thirty miles an hour was suggested, it was ridiculed as an idea simply insane. "Such a fearful velocity would, without doubt, have the most disastrous effects upon the circulation of the blood and the vital organs."

We have seen what was the time consumed between London and Paris: let us now glance at

A Diligence.

the conditions which obtained in 1843 by the chief routes:

By Dover and Calais.

	Miles.	Hours.
London to Dover (by railway) .	88	3½*
Dover to Calais (by steamer) .	25	3
Calais to Paris (by *diligence*) .	178	23
Total .	291	29½

By another route, *via* Brighton and Dieppe, the journey to the French capital was made as follows:—

	Miles.	Hours.
London to Brighton . . .	50½	2
Brighton to Shoreham . .	5	0¼
Shoreham to Havre . . .	94	9
Havre to Paris	132	13
Total .	281½	24¼

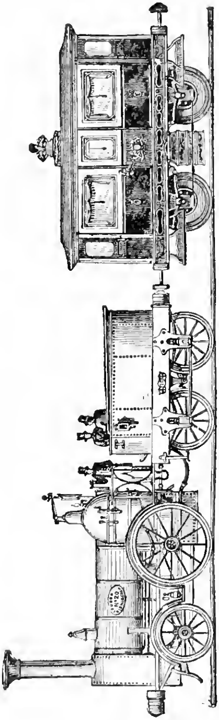
When in 1839 the Midland Counties Railway was opened the only modes of conveyance were the canal, the fly-wagon, and the coach. Only three of the latter ran daily each way between Leicester and Nottingham. A wool-stapler stated at the time that he frequently had from twenty to five hundred bags of wool lying at Bristol which could not be brought forward by land, and he had, therefore, to divide the bulk and send it by different routes; the part despatched by the road taking from a week to ten days in transit, and that

* In 1842 it is given in "Murray's Guide" as five hours

by water from three weeks to a month. So great were the difficulties at Plymouth that goods had usually to go by sea to London.

Yet in the early days of railways great speed was attained on special occasions. Mr. Allport has recalled that in 1845, before the era of telegraphs, when "the battle of the gauges" (*i.e.*, between the broad and the narrow gauge system) "was being vigorously carried on, I wished to show what the narrow gauge could do. The election of George Hudson, as member for Sunderland, had that day taken place, and I availed myself of the event to see how quickly I could get the information up to London, have it printed in the *Times* newspaper, and brought back to Sunderland. The election was over at four o'clock in the afternoon, and by about five o'clock the returns of the voting for every half-hour during the poll were collected from the different booths, and copies were handed to me. I had ordered a service of trains to be in readiness for the journey, and I at once started from Sunderland to York, another train was in waiting at York to take me to Normington, and others in their turn to Derby, to Rugby, to Wolverton, and to Euston. Thence I drove to the *Times* office and handed my manuscript to Mr. Delane, who, according to an arrangement I had previously made with him, had it immediately set up in type, a leader written, both inserted, and a lot of impressions taken. Two hours were thus spent in London, and then I set off on my return journey and arrived in Sunderland next morning at about ten o'clock, before the announcement of the poll. I there handed over copies I had brought with me of that day's

Times newspaper, containing the returns of what had happened in Sunderland the afternoon before. Between five o'clock in the evening and ten



The Royal Train in 1843, London and Birmingham.

that morning I had traveled 600 miles, besides spending two hours in London,—a clear run of forty miles an hour."

It was at this period of the railway mania that

one express steamed up to London, 118 miles, in an hour and a half, nearly eighty miles an hour.

In 1846 the distance between London and Exeter (193¾ miles) was regularly accomplished in four hours and a half. In the same year the distance between London and Liverpool (210 miles) occupied just six hours.

In 1842 the Great Western Railway caused some interesting experiments to be made with regard to speed. On one occasion an expert driver ran his train over the eighteen miles between London and Slough in fifteen minutes, which was at that time the maximum speed which had ever been attained on a railway. Six years later the fifty-three miles between London and Didcot were traversed in forty-seven minutes.

For many years the reputation of being the fastest train in the world was enjoyed by the *Flying Dutchman.* The distance between London and Swindon, seventy-eight miles, was regularly done in one hour and twenty-seven minutes, which was at the rate of fifty-three miles an hour. In 1880, Exeter, 194 miles, was reached in four and a quarter hours, or at an average pace, including stoppages, of forty-five and a half miles an hour.

Compare this schedule traveling by established routes with the seven hours from London to Swindon in 1830, or the twenty hours from London to Exeter, at the same epoch of the fast mail-coach.

Since the journey between London and Manchester had been cut down to four and a half hours, twenty-five years elapsed before it was found possible to diminish it. In 1885, however,

the three great lines and twelve expresses, each accomplishing the distance in four and a quarter hours, on some portions of the road over sixty miles an hour being made.* Between Crewe and Rugby, seventy-five and a quarter miles were covered in one hour and thirty-seven minutes. From Manchester to Sheffield is forty-one miles, and this journey is regularly done in fifty-nine minutes, including a twenty-mile gradient and a three-mile tunnel. It became possible at about the same time for a resident at Grantham to travel to London, 186 miles, in one hour and fifty-seven minutes, a journey which would have taken his grandfather eleven hours to accomplish by the best mail-coach on the road.

By a new service London and Birmingham are now brought within two hours of each other. This is a saving of a full half hour over the time for 1901. London to Holyhead now takes five hours.

The journey from London to Edinburgh has from time immemorial been regarded as the criterion of rapid traveling in Great Britain. We have seen that the high-water mark of the Edinburgh mail in 1820 was forty hours, stoppages included. To-day one may complete the journey of 392 miles *via* the Great Northern Railway in eight hours and fifty-five minutes. From London to Leicester (100 miles) is now regularly done in two hours; from London to Leeds (186 miles), in three hours, fifty-five minutes, and London to Brighton (fifty-one miles), in fifty-one minutes.

To the Midland Railway is due the credit of

* The duration of the journey has now (1903) been curtailed to less than four hours.

first running third-class carriages by all trains. Up to March, 1872, progress for the ordinary passenger was provokingly and scandalously slow. Not only was the average speed scarcely more than fifteen miles an hour, but the traveler was forced to start at an uncomfortably early hour to catch the only train that ran. The reform was hailed with joy all over the kingdom. "When," observed Mr. Allport, "the rich man travels, or if he lies abed all day, his capital remains undiminished and perhaps his income flows in all the same. But when a poor man travels he has not only to pay his fare, but to sink his capital, for his time is his capital; and if he now consumes only five hours instead of ten in making a journey, he has saved five hours of time for useful labor—useful to himself, to his family, and to society." The change, which had taken twenty-five years to come about, resulted in enhancing the passenger traffic of the English railways fourfold.

If we wish to obtain an idea of the speed to which railway trains were brought in less than fifty years after their introduction, we have only to compare it with the velocity of a cannon-ball. According to the investigations of Dr. Hutton, the flight of a cannon-ball with a range of 6,700 feet takes a quarter of a minute, or at the rate of five miles a minute, or 300 miles an hour. Hence it follows that a railway train moving at seventy-five miles an hour has one-fourth of the velocity of a cannon-ball—moving at 100 miles an hour it has one-third that velocity. It may therefore be considered as a huge projectile, subject to the same laws that govern projectiles, but

weighing 100 tons instead of 100 pounds. When a train is running at fifty miles an hour, the pistons are working along the cylinders at the rate of 800 feet a minute. When running at seventy miles an hour, the pace of the train is at the rate of 105 feet per second, so that if two trains pass one another, each going at this speed, they would flash past each other in a single second, even if one were seventy yards long.

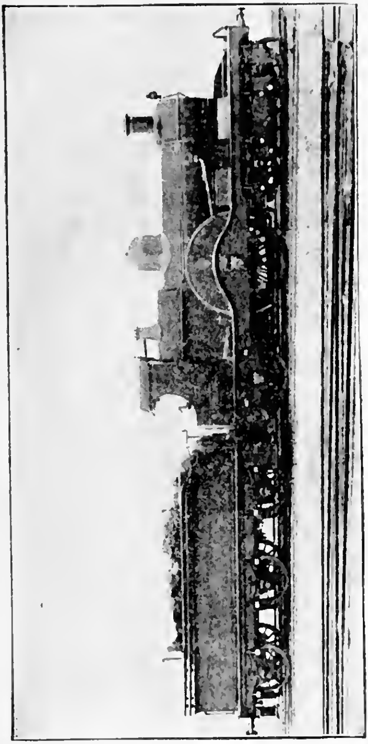
Nine-tenths of the fast or express trains in England reach the standard of "thirty miles an hour, including stops" (or a journey speed of forty miles an hour), and the other tenth fall short only because their journey is exceptionally hilly, or exceptionally brief, or subject to delay. The above regulation test, therefore, for any train wishing to be called "express" in England is not an artificial one, but a natural definition supplied by the companies themselves on their daily timetables.*

A modern railway authority informs us that on the Continent of Europe as a rule a train is held to be magnificent, worthy of heroic adjectives, and not to be rudely attempted by third-class passengers, if its journey-speed is as high as twenty-nine miles an hour, trains there which attain such speed form a group and tower above the rest, just as in England it is trains that reach forty miles an hour, inclusive, which stand apart from the common stopping train.

Considerable more force has to be expended to attain this speed than would appear at first sight. "Imagine a train shot suddenly out from its starting-point at forty miles an hour, main-

* E. Foxwell, "Express Trains."

taining with unflagging uniformity this same high speed uphill, through suburbs and junctions,



Great Western Railway—The *Flying Dutchman.*

persisting this pace without a moment's pause for two or three hundred miles till it come to an instantaneous stop at its distant terminus; the

mildest of the trains we call "express" will arrive as soon as this imaginary one, though our actual train has had to labor slowly up the hills, to slack for bridges, curves, or junctions, besides consuming precious time in four or five stoppages of as many minutes each. The feeblest 'express' is as smart as this; what then shall we say of trains which secure an 'inclusive speed' of nearly fifty miles an hour over summits of 1,000 feet?"

The Great Northern Railway has the shortest route to Leeds, Bradford, York, and Edinburgh, being eight miles shorter to the latter city than the North-Western, and fourteen shorter than the Midland route. In the mere matter of speed this railway, as well as the Midland, is superior to the oldest and most punctual of the English railways, the North-Western, which has long enjoyed the distinction of being called the "leading line." Its rolling stock is probably the best in the kingdom, and some of its achievements between London and Liverpool and London and Edinburgh exhibit a very high rate of speed.

In the summer of 1888 the three great lines which start from Euston, St. Pancras, and King's Cross resolved upon an attempt to beat their own record to Edinburgh. The best long run made up to that time was that achieved by a special train on the Great Northern Railway in July, 1880. It was conveying the Lord Mayor of London to Scarborough. The distance from London to York, 188 miles, was accomplished in 217 minutes, which implied an average, including a ten minutes' stoppage at Grantham, of fifty-two miles an hour. The first fifty-three miles from London were done in an hour, not ten miles of the road

being level. Stoke, 100 miles, was passed in one hour and fifty-one minutes; while between Barkstone and Tuxford, twenty-two and a quarter miles, the speed was at the rate of sixty-four miles an hour. At that period, the ordinary express trains of the line occupied three hours and forty-eight minutes—or twenty-one minutes more on the journey.

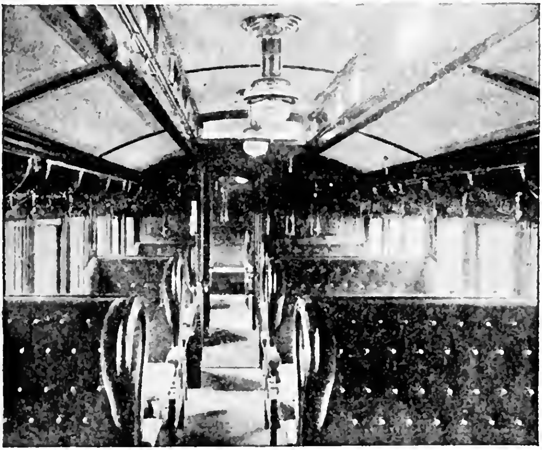
In August took place the first of the exciting races to Edinburgh, when the daily performance of each of the rival expresses was wired in detail to the newspapers. The origin of the competition was the action of the Great Northern Railway in announcing some months before, that it would carry third-class passengers in its night express to Edinburgh and Glasgow, which took nine hours to the former city and ten hours twenty minutes to the latter. This was throwing down the gauntlet to the North-Western, inasmuch as it was in the one case nearly an hour quicker than that company's best third-class express.

By the new arrangement, therefore, third-class passengers could arrive in Edinburgh one hour sooner by the Great Northern line. The *doyen* of railways quickly responded by lowering its time to nine hours between Glasgow and Edinburgh and Euston. In addition, a new express was put on for Perth, leaving Euston at 10.30 and arriving in Perth at 9.35, twenty minutes quicker than before. Admirers of speed were delighted at these evidences of youthful enterprise on the part of an old-established line up to then content to work its trains at a velocity less brilliant than either of its two rivals.

Early in June the response of the Great Northern came. It gave notice that it intended forthwith to shorten its Edinburgh and Glasgow journeys by half-an-hour both ways, making the time for Edinburgh eight and a half hours, and for Glasgow nine hours fifty minutes. The interested public were also informed that the Midland line intended to lop a whole hour off their fastest time to Glasgow, and twenty-five minutes off that to Edinburgh, thus doing the former journey in eight hours twenty minutes (twenty minutes longer than the North-Western, whose route is twenty miles shorter) and Edinburgh in nine and three-quarter hours.

But the North-Western was not to be beaten: it felt its prestige at stake and abruptly gave three days' notice that from August 1st they too would run to Edinburgh in eight and a half hours. This sudden move at the eleventh hour seemed to render it impossible for the other road to arrange reprisals in time to secure the bulk of the holiday traffic. Nevertheless, the Great Northern in a few hours issued its working notices all over the line announcing that from August 1st by their route the journey to Scotland would be done in *eight* hours. The third competing railway, recognizing the futility of further long-distance rivalry, fell out of the running and kept to their previous programme. The last days of July were a stirring experience for the "Office of the Superintendent of the Line" at King's Cross and Euston. The urgent introduction of such extraordinary "accelerations" as these, involving special "shunts" and signal-box instructions all along the line the whole length of the route, demanded the utmost

coolness and executive skill—especially as the "accelerations" were wrought in the very busiest week of the railway year. An alarmist cry of "Danger" went up from certain newspapers and excitable individuals, and all sorts of horrors were wildly predicted, as a result of this velocity.



Interior of a Third-class Dining-car, Midland Railway.

During the first week the North-Western, finding they ran over Shap summit easily in the shortest time (at fifty-one and a half miles an hour), and the Caledonian still more easily (fifty miles an hour), gave notice that they would equal the speed of the Great Northern. Yet every day the rival expresses ran within the time, the West Coast train on the opening day actually saving fifteen minutes on the road, arriving at Edin-

burgh at 5.52. The ninety miles from Preston to Carlisle, a steep incline, was done in eighty-nine minutes. As the rival line had also been running under time, it decided that its express should arrive in the Scotch capital at 5.45, or seven and three-quarter hours, from London. The North-Western cheerfully followed suit, and got into Edinburgh in seven hours thirty-eight minutes. The Great Northern then did the journey in seven hours thirty-two minutes, and with that achievement the contest suddenly came to an end. Negotiations took place and a compromise was effected, the West Coast relapsing to its previous programme of eight hours, while the East Coast, being eight miles shorter, was permitted to make the transit in seven and three-quarter hours. But although "racing" ceased, phenomenal speed was maintained to the end of the month, and on August 28th the East Coast express reached Edinburgh at 5.29, three minutes sooner than the best previous records. The North-Western responded with a farewell performance, beating this record by one minute in spite of the longer distance. On one day of this race of 1888, Crewe to Preston (fifty-one miles) was done in fifty minutes; Preston to Carlisle (ninety miles) in eighty-nine minutes; Carlisle to Edinburgh (100¾ miles) in 102½ minutes; and Newcastle to Edinburgh (124 miles) in 124 minutes. So smooth was the motion that the unsuspecting passengers were unaware they were taking part in a feat that, on level ground, would have been without a precedent.

The "race to the North" was resumed by the rival railways in 1895. In June of that year the

best trains between London and Aberdeen took eleven hours thirty-five minutes by the East Coast route (523 miles), and eleven hours fifty minutes by the West Coast (540 miles). From July 1st the latter accelerated their time by ten minutes, and their rivals, taking this as a challenge, immediately lowered their time by twenty minutes. The West Coast responded a fortnight later by an acceleration of forty minutes, and a pitched battle ensued, raging fiercely for a month. Although the West Coast maintained the lead in arrival at Aberdeen almost throughout, yet allowing for stoppages, weight of train, etc., there was not much to choose between the two competitors. On August 22d the 8 P.M. train from Euston reached Aberdeen at 4.32 A.M., an acceleration of no less than three hours eighteen minutes on its speed before the racing began. This meant an average of 63.3 miles an hour, including stoppages. The expense, if not the risk, of these high-pressure speeds led to an agreement, and the rivalry suddenly ceased. Nevertheless, the September *Bradshaw* showed that ten and a half hours would be the future time between London and Aberdeen, a saving of more than one hour on the old time, besides a considerable improvement in the speed to Inverness, Perth, Glasgow, and Edinburgh. Moreover the contest restored to Great Britain the record for daily long-distance fast traveling which for three previous years had been held by the Empire State Express, which runs from New York to Buffalo (440 miles) in eight hours forty minutes. This now became beaten both by the West Coast time to Perth (450 miles) in eight hours forty

minutes, and by the East Coast time to Dundee (452 miles) in eight hours forty-seven minutes.

As a rejoinder, on September 11th the New York Central Railway ran a racing train from New York to Buffalo, which performed the journey in six hours fifty-one minutes, an average speed (including stoppages) of 64.22 miles an hour.

Another important acceleration of railway speed brought about in 1895 was on the Great Western Railway between London and Bristol, Bath and the west of England generally. It was accomplished by the purchase of the Swindon Junction Hotel property which was held by its owners under an extraordinary agreement which made it obligatory to stop all passenger trains passing through Swindon, ten minutes for refreshments. This ridiculous arrangement dated from 1841 and was for ninety-nine years. In order to annul it the Great Western Company had to pay no less than £100,000.

Since the "race to Edinburgh" of 1888, there had been an understanding that neither of the rival companies should time their day trains quicker than eight and a half hours. Twelve years later, however, in November, 1900, the East Coast route announced that thereafter it would accelerate its "Flying Scotsman" so as to do the journey in eight and a quarter hours. The West Coast Company did the same. It was believed that the first-named company were extremely desirous of winning back to Great Britain the record for railway speed which, in the interval, had again passed first to the United States and then to France. For the title of the fastest

train in the world, once belonging to the "Flying Scotsman," was in 1900 bestowed upon the "Sud Express" of the Orleans Company, which averaged fifty-four miles an hour, including stoppages, for a journey of 486 miles. But this rate of speed is a remarkable exception for France.

The accepted definition of an English or American express train is one whose speed, inclusive of stops, is at least forty miles an hour. This figure, we are told, exhibits the relative efficiency and energy of the traffic administration, while the "running average," as it is called, may show a much higher degree of speed, excluding the stops.

Very few Continental express trains attain a journey speed of forty miles an hour, the average being considerably less. In 1888 the distance between London and Brindisi, 1,455 miles, took fifty-two hours, which, fast as it would have seemed to our grandfathers, was yet only an average of twenty-six miles, or no faster than such ships as the *Umbria*, *Etruria*, and *Express* went on the Atlantic.

The St. Gothard Tunnel was begun in 1872 and finished in 1880; it measures nine and a quarter miles in length, is twenty-six feet wide and twenty-one high, and cost £2,270,000 to build. In connection with the railway, which climbs up the lower slopes of the St. Gothard and descends on the other side, it is possible to cross the Alps from Lucerne to Bellinzona, 105 miles, in three and a half hours; fifty years ago it required twenty-three hours.

In the United States, the country perhaps where time and speed are most prized in the

affairs of life, rapid transit has, within the last twenty years, grown to be universal. Urban and local transit forms a feature of itself, but in the speed of the ordinary railways it is only lately that the American lines have equaled those of Great Britain. The best running in the United States is between New York (Jersey City) and Philadelphia, between New York and Buffalo, and between Boston and Providence. The journey from Camden to Atlantic City (55½ miles) is done in fifty minutes.

The first railway built in the United States was from the granite-quarries of Quincy, Mass., to tide-water, length five miles; begun in 1826 and completed in 1827, it was built to supply the granite for the Bunker Hill Monument, and made of wooden rails laid on granite sills, with a strap-rail of rolled iron. The second road was begun in January, 1827, and completed in May of the same year, extending from the coal-mines to the Lehigh River at Mauch Chunk, Pa.—a distance of nine miles. The loaded cars passed down the inclined planes by gravity, and the empty cars were drawn up by mules. The rails were of timber, covered with a strap of iron. In 1828 the Delaware and Hudson Canal Company constructed a railway, sixteen miles long, from its coal-mines to Honesdale, the termination of the canal, to transport the anthracite coal to tide-water. These were followed rapidly by the Baltimore and Ohio, the Mohawk and Hudson, the South Carolina, the Camden and Amboy, the Ithaca and Owego, and the Lexington and Ohio, which at the close of the year 1830 had

92 miles built and 463 miles projected or under construction. All of these roads, with the single exception of the Delaware and Hudson, were built for and operated by horse-power.

In January, 1828, Horatio Allen, of the Delaware and Hudson Canal Company, went to England to procure the iron rails for that company's road, and also, at his discretion, to order three locomotive engines. He accordingly ordered one engine from the works of Foster, Rastrick & Co., of Stourbridge, and two engines from the works of Robert Stephenson at Newcastle. These orders were given in the early summer of 1828, and the engines were received in New York in the following winter (1828-29). The burning of anthracite coal in the furnaces of engines was the point to be demonstrated by the Delaware and Hudson Canal Company, whose extensive mines were waiting a demand on the part of the public, the total consumption of anthracite coal having reached but about 80,000 tons yearly. In the spring of 1829 one of these three engines was ordered to be sent by river and canal to Honesdale, Pa., the initial point of the company's railway. The accident which sent the Stourbridge engine rather than either of the other two had not been accounted for. The other two engines were precise counterparts, and identical in boiler, engine, plan, and appurtenances with the *Rocket*, by the same maker, which subsequently startled the world by its performances at Liverpool. The *Stourbridge Lion*, as the engine was named, was put upon the track—built of hemlock timbers and strap-rails,

with timber trestles thirty-five feet in height, and curves of 720 feet radius—and on August 8, 1829, Mr. Allen ran the engine himself for six miles at good speed amid the cheers of the incredulous spectators. No load was attached, as it was feared that it would prove too severe for the road, but it was the first trip ever made on a railway by a locomotive engine in America.

The first locomotive built in the United States was made by the West Point Foundry for the South Carolina Railroad Company, after plans by the chief engineer, Horatio Allen, and was first put upon the road November 2, 1830. Thus began an industry that in the hands of Baldwin, Campbell, Rogers, and other masters has grown to be one of the most important in the United States. In speed, durability, and in its adaptability to every kind of condition and service the American locomotive is unequaled, and stands to-day one of the most perfect monuments of human skill and ingenuity.

The flat rail was soon abandoned in the United States, the New Orleans and Lake Pontchartrain Railroad adopting the T-rail in its construction in 1830-31. In 1840 there were 2,816 miles of railroads in the United States; in 1850, 9,015 miles; in 1860, 30,600 miles; in 1870, 52,856 miles; in 1880, 93,526 miles; in 1890, 161,397 miles; in 1900, 193,304.

In the old days it took a whole day, with relay of horses, to travel from Baltimore to Washington, a distance of only forty miles; when railways were introduced it was accomplished in two hours; in President Lincoln's

time it was done in a little more than an hour. It now regularly takes forty-five minutes, and has been done in less.

The ninety miles between New York and Philadelphia is now covered in ninety minutes. The journey to Chicago, 911 miles, takes less than twenty-four hours, by one line; and although sixty miles longer by another route, the New York Central, is accomplished in the same time, at an average speed for nearly 1,000 miles of forty miles an hour. And both the Pennsylvania and New York Central now have trains covering the distance from New York to Chicago in twenty hours. Chicago to San Francisco takes eighty-nine hours and to cross the entire continent from New York, four days, eight hours.

In 1902 in Great Britain the three northern companies had together forty expresses between London and Scotland. In 1883 there were sixteen; in 1885 there were nineteen, and in August, 1888, twenty-nine. There is thus an increase of fifty per cent. in the number of Scotch expresses since 1883, and their average speed has also increased.

On the Great Western there are four express trains (led by the *Dutchman* and *Zulu*) which have an average speed, including stops, of fifty miles an hour between London and Exeter. The distance between London and Penzance was covered in eight hours fifty-five minutes in 1889; it is now done in eight and a half hours.

The following may be taken as the best express service now regularly running in various

parts of the globe in miles per hour, including and excluding stops, respectively:—

England . .	London to Birmingham .	53.4	58
United States .	Camden to Atlantic City .	...	61.3
France . .	Paris to Calais . . .	56	66.6
Germany .	Berlin to Hamburg . .	393	43.5.

As to the average rate for express trains we may quote the appended figures, all trains running above forty miles an hour being "express" in Great Britain and America, and all above twenty-nine miles an hour on the Continent:—

Great Britain,	with stops,	41.6;	without stops,	44.6
France	"	32.8	"	36.2
Holland	"	32.5	"	35
Germany	"	31.7	"	34.3
Belgium	"	31.7	"	33.5
Austria	"	30	"	32
Denmark	"	30	"	32
Italy	"	29½	"	31.2
Sweden	"	29	"	31.5
Russia	"	29	"	31.6
United States	"	41.4	"	...

The speed of American expresses was, fifteen years ago, from thirty-five to forty miles an hour. It has now been raised to over forty. In France the Northern Railway runs its expresses at an average of thirty-seven, and the Paris, Lyons and Mediterranean at thirty-four miles an hour. Several of the German expresses cover thirty-six miles an hour; the Swiss expresses, over difficult gradients, only twenty-two miles; the Dutch expresses, thirty-three and a half miles; the Belgian, thirty-three

miles; the Scandinavian, twenty-one miles; the Italian, twenty-seven miles; the Indian, thirty-three miles; and the Russian thirty-four miles an hour.

The journey from Berlin to St. Petersburg, 1,028 miles, takes forty-six hours, or an average of thirty-two and a half miles an hour. Compare this with an express on the Lake Shore and Michigan Southern Railway which did the journey between Buffalo and Cleveland, 183 miles, in 187 minutes, exclusive of stops. Allowing for time consumed in slowing down, 172 miles of the distance was run in 161 minutes, averaging 64.26 miles an hour. Short distances were covered at the rate of seventy-five miles an hour.

The Orient Express leaves Paris and Constantinople twice a week, and takes five days to do the journey. By leaving London at 10 A.M., and traveling by Chalons, one reaches Vienna at 5.50 the following evening; Budapest at 11 P.M.; Belgrade at 6 A.M.; Sofia at 4 P.M.; and the conclusion of the third day finds you at Constantinople.

The Indian mail train, chartered by the British Government, traverses 1,375 miles, and in fifty-eight and a quarter hours reaches Brindisi, where the passengers take a steamer for Alexandria, and from there reach Bombay in fourteen days from London.

The distance between Paris and Marseilles (536 miles) was in 1888 done in fourteen hours nineteen minutes. The speed has since been raised to fifty-seven miles an hour. The fastest train in France is that between Paris and Calais (185½ miles), doing the journey in three hours

fifteen minutes. This excels the time of any fast train in England.

Germany and Belgium, while not as bad as some other countries in this respect, such as Italy and Spain, are yet far behind England and America in the matter of rapid railway transit, perhaps owing to the fact of state-owned lines and the consequent lack of competition.

In 1891, on the Canadian Pacific line, a special train conveyed the Japanese mail from Vancouver to Brockville, Ont. (2,800 miles), in seventy-seven hours, or a speed of thirty-six miles an hour for the whole of this vast run. On the Grand Trunk Railway of Canada the best service is 36.8 miles, including stops, and 39.2 excluding stops. The best service in India is from Bombay to Calcutta, about twenty-five miles an hour. In Australia from Melbourne to Sydney is run at thirty-three miles an hour, including stops, and thirty-seven excluding stops.

Less than forty years ago Jules Verne wrote his entertaining romance, "Around the World in Eighty Days." He was thought to have exceeded all bounds of possibility; at that time the circumnavigation of the globe never had been accomplished in less time than 121 days. In 1873 it was done in 109 days. Eventually, an American performed the feat in ninety days, and in 1891 a Miss Bisland lowered the time to seventy-two days. Since then the record has stood at sixty-nine days, the main obstacle being to traverse speedily the mighty tract of Asia.

Eastern Siberia, which a few years ago was one of the most remote districts on the face of the globe, will soon be as accessible as Canada.

The First Electric Railway.

The connection between Russia and Siberia forms the greatest railway scheme in the world. The first sod was cut at Vladivostock May 24, 1891; and to facilitate the work of construction the line was divided into three parts. When the whole is completed in 1904 it will be possible for a traveler to circumnavigate the globe in thirty days! The distance from Moscow to Kaidalovo is 4,146 miles. Even in the incomplete state of the line, by means of the lakes and rivers, uninterrupted steam communication between the railway system of Europe and Vladivostock on the Pacific was rendered possible in 1901. From Cheliabinski, the first station in Western Siberia, to Stretensk *via* Omsk, Tomsk, and Irkutsk is a distance of 2,762 miles. This section of the journey comprises the passage of Lake Baikal, just beyond the Irkutsk. For this passage icebreaker ferries have been specially built, capable of transporting a complete railway train across the lake. From Stretensk a steamer travels 1,443 miles to Khabarovsk, and from the latter place to Vladivostock by rail is 485½ miles. The entire journey takes seventeen days.

From Paris to Vladivostock was timed in 1901 at twenty-four and a half days, and a further reduction of time will be secured now that the railway round the south end of Lake Baikal is completed.

At present there is no direct fast train from Paris or Berlin to Moscow, but as soon as the Siberian Railway begins to run through trains, this gap between West and East will be bridged. Yet, strange to say, it takes even now less time to reach London from St. Petersburg than from

Naples. The traveler leaves by the Nord Express at 10 A.M., Monday, and by 3 P.M. on Wednesday he is on the banks of the Neva — fifty-three hours. By this same express Berlin is twenty-one hours from London.

Quite recently the Siberian (or Eastern China) Railway has come to an arrangement with the International Sleeping Car Company for improving the facilities of travel on the line. To this end 100 sleeping-cars are supplied by the company, which will be attached to the express trains running between Irkutsk, Vladivostock, and Port Arthur. These through trains will be made up once a week exactly on the same lines as the through trains which run now between Moscow and Irkutsk, and one car will perform the entire journey from Moscow to Peking. With the introduction of this train service it will be possible to travel overland from London to Peking in fourteen days. In 1804 it took twenty-nine weeks.

The first attempt to apply electric power for the propulsion of railway locomotives was by R. Davidson on the Edinburgh and Glasgow Railway in 1842; but a speed of only four miles an hour was attained and the project was abandoned. Electricity was employed in 1881 by Messrs. Siemens & Halske on an electric railway in Berlin; a line being subsequently built one and a half miles long from Charlottenburg to the Spandauer Bock. They also applied the system to a short railway at Amsterdam and to another in Zankerode in Saxony. Great attention was attracted in that year to an electric line operated at the International Electrical Exhibi-

tion in Paris by the Siemens system. It carried an average of 13,000 passengers per week, few amongst whom did not perceive the possibilities which electricity offered to the future of rapid transit. Two years later an electric railway, six miles long, was opened in Ireland, between Portrush and Bushmills in the north of Ireland. The conductor employed was a third rail, electricity being transmitted through this conductor by means of steel brushes to the Siemens motor by which the car was propelled. The dynamo machines were driven by the power of a natural water-fall of twenty-six feet, causing two turbines to revolve at a speed 225 revoluticns per minute, each of which was capable of yielding fifty horse-power. The cars on this road ran at the rate of twelve miles an hour. It was not long after this that a number of electric tramways or railways were constructed in various parts of Europe and North America. The Liverpool overhead railway was opened in 1893.

CHAPTER V

THE TELEGRAPH—WIRELESS TELEGRAPHY

When Shakespeare made Robin Goodfellow declare that he would girdle this terrestrial globe in forty minutes, it was considered a ludicrous stretch of the poet's imagination. No one could have dared to suppose that the day would come when such a statement would become a mere truism—indeed, a far too modest statement of a fact which has grown commonplace.

The idea of annihilating time and space in communication by distant signals is sufficiently ancient to have occurred even to the most uncivilized tribes. The North American aborigines were wont to convey intelligence thus from hill to hill, and the Hottentots communicated with each other by means of hill-top fires.

It is not requisite to mention the various means of conveying information to a distance by means of sound known to our ancestors, but it might be profitable to glance at the origin of Telegraphs, before electricity came to be employed.

The first practical telegraph dates from 1684, and was that of Dr. Hooke, the mathematician, an inventor of many ingenious instruments. His method consisted in exposing successively as many different shaped figures or signs as there are letters in the alphabet. If used in the daytime, they might be squares, circles, triangles, etc., and at night torches or other lights disposed in a certain order. These characters or signs were to be brought forward from behind a screen attached to a movable rod. Of this "telegraph" the stations were to be at such convenient distances as to enable the signals to be seen with a moderately powerful telescope. It is obvious that such a plan, although clever, was also very complicated, owing to the number of signals. But its inventor was so confident of its practical utility that he declared that "the same character might be seen at Paris within a minute after it had been exposed in London." It is certainly a pity that the system was not

tried, at least between London and York or Edinburgh.

More than a century later, when Europe was in the throes of war, many experiments were made with the telegraph, the principal object being to simplify the mechanism.

The first to render a telegraph available for practical purposes was probably Amontons in 1690. It is related by Fontenelle that he invented "a means to make known all that was wished to a very great distance—for example, from Paris to Rome—in a very short time, three or four hours, and even without the news becoming known in all the intervening space." This proposition, so paradoxical and chimerical in appearance, was executed over a small extent of country. The secret consisted in placing in several consecutive stations persons who, by means of telescopes, having perceived certain signals at the preceding station, transmitted them to the next and so on in succession; and these different signals were so many letters of our alphabet, of which the key was known only at Paris and Rome.

Other attempts were made in the course of the ensuing century to induce the French Government to take up various schemes of telegraphy. At last, when the country was plunged into the horrors of war, one Claude Chappe laid plans before the Legislature in 1792, assuring them that "the speed of the correspondence would be such that the legislative body would be able to send their orders to the frontiers and receive an answer back during the continuance of a sitting."

After much vexatious delay the authorities approved of the scheme, and Chappe, with the title of Ingenieur Telegraphe, was directed to construct a telegraph from Paris to Lille. The line, with its apparatus (a combination of a pole, a beam, movable arms and ropes) which allowed of the transmission of 192 different signals, was completed in two years. The first message sent announced a victory. On the last day of November, 1794, Carnot entered the Assembly with the news, "Condé is given up to the Republic! The surrender took place this morning at six." The Chamber voted that "the army of the North had deserved well of the country;" this message was sent instantly to headquarters, and before the day's session broke up the members were informed that their orders had been transmitted 150 miles to Lille and acknowledged by the commander there.

Such a successful result of course led to the immediate formation of other lines which radiated from the French capital to all parts of the kingdom. The signals (depending on varying positions of the beam and arms) were conveyed with great rapidity; and to avoid confusion, the movable arms on the right of the central post were reserved exclusively for Government messages, those on the left being employed in the service of the line. By this means, accidents or delays could be reported without detriment to the official despatch; and the Government was enabled to employ a cipher code of its own.

From Paris to Calais, a distance of 152 miles, there were thirty-three stations, and a message

could be sent from one extremity to the other in three minutes; to Strasburg, 255 miles and forty-four stations, in six and a half minutes; to Toulon, 317 miles and 100 stations, in twenty minutes. The longest lines were to Brest and Bayonne, the former 325 miles, the latter 425; and altogether there were 519 stations, the annual cost of the service amounting to £40,000. The brothers of the inventor Chappe succeeded him in turn, the last being in office until 1830, when the Revolution of that year deprived him of his post.

A system of such value could not but be instantly appreciated by neighboring countries, whose enterprising inventors proposed to each Government various forms of apparatus. Among those who submitted their plans was the father of the celebrated Maria Edgeworth, who contrived a telegraph of four wedge-shaped boards, mounted on the tops of poles and so pivoted as to assume various positions. Edgeworth believed his system was easily capable of serving for the transmission of messages all the way between England and India.

Another inventor, named Gamble, devised an apparatus of shutters to fill the openings in a window frame, different signals being conveyed by the alternate opening and shutting of the spaces. Lord George Murray in 1795 substituted a different arrangement of shutters; they being six in number, painted black, the different letters and figures being indicated by the situation of the open shutter. The Admiralty adopted this plan for a telegraph between London and Dover. In 1806, Davis's sliding shutter in-

creased the value and celerity of Murray's arrangement, but ten years later the whole principle of shutters was abandoned by the authorities for a modification of the older movable arm system. In 1816 the telegraph or semaphore, long familiar to the public, on the roof of the Admiralty, was erected. It was invented by Sir Home Popham and consisted simply of an upright pole with two movable arms. It was not capable of a large number of signals; but it proved simple and effective and the angular position was easily seen at a distance. The time between London and Dover was reduced for long messages, and Popham's telegraph continued in use until it, and all its kind, was superseded by the wonder-working magnetic flash. It was, of course, useless at night, or in fogs and dull weather; and for three quarters of the year the telegraph from the capital to Portsmouth stood idle. As an illustration of one of its drawbacks, on one occasion, when tidings of moment were expected from Spain, the Admiralty officials received a message—"Wellington defeated." The utmost disappointment and depression prevailed, until the arrival of the royal messenger with the despatches, when it was found that the fog had delayed the rest of the message, which should have been "Wellington defeated the French at Salamanca."

But the era of electro-telegraphy was now at hand, and a means was about to be adopted which placed all the laws of time and distance at defiance. As far back as 1736 Stephen Gray had found that by means of pack threads, more

than 100 feet in length, the electric current could be transmitted to a considerable distance.

In France, two other experimenters, Dufay and Nollet, sent a current along a wet cord 1,300 feet. Dr. Watson carried a wire across the Thames at Westminster Bridge, one end being in contact with a charged Leyden jar, the other held by a person on the opposite shore. Another individual was placed in communication with the jar, and on a given signal both dipped an iron rod into the river, whereupon the charge traveled from one bank to the other by means of the wire, and completed the circuit by returning through the water. That this discovery was of a most important character it is not necessary to emphasize, seeing that it involved the principle governing all subsequent experiments in electrical transmission of this kind.

Scarce had the nature of this new and most astounding agency become known before it was followed in various quarters by proposals to employ it in the conveyance of signals. It is related that as early as 1773 Odier wrote to a lady of his acquaintance: "I shall amuse you, perhaps, in telling you that I have in my head certain experiments by which to enter into conversation with the Emperor of Mogul or of China, the English, the French, or any other people of Europe, in a way that, without inconveniencing yourself, you may intercommunicate all that you wish at a distance of four or five thousand leagues in less than half an hour! Will that suffice you for glory?"

This vivacious spirit was not alone. In 1774,

Lesage, a Frenchman at Geneva, published a plan for an electric telegraph. He proposed to arrange twenty-four metal wires in some insulating substance, each connected with an electrometer, from which a pith ball was suspended. On exciting the wires by means of an electrifying machine, the movements of the twenty-four balls represented the letters of the alphabet.

Under date of September 16, 1787, Arthur Young, in his "Travels in France," remarks: "In the evening to Monsieur Lamond, a very ingenious and inventive mechanic. In electricity he has made a remarkable discovery. You write two or three words on paper; he takes it with him into a room and turns a machine enclosed in a cylindrical case, at the top of which is an electrometer, a small, fine pith ball; a wire connects with a similar cylinder and electrometer in a distant apartment; and his wife, by remarking the corresponding motions of the ball, writes down the words they indicate. . . . As the length of the wire makes no difference in the effect, a correspondence might be carried on at any distance; within or without a besieged town, for instance; or for a purpose much more worthy, and a thousand times more harmless—between two lovers prohibited or prevented from any better connections." Here, then, was a complete electric telegraph on a limited scale, and yet years were to elapse before it was put publicly into practical effect.

We have seen that Chappe's invention of signals was adopted instead, and probably delayed the discovery or employment of voltaic electricity. In 1796, Salva, a Spanish physician, con-

structed an electric telegraph, which was made useful; and soon afterward a more extensive attempt was made by Betancourt, who stretched wires from Aranjuez to Madrid, forty-five miles distant, conveying signals by the discharge of Leyden jars. But nothing really came of these attempts, because the experimenters had not yet hit upon the right agency. Frictional electricity and galvanism differ in many ways; one will leap over short distances and is uncertain, the other seems to require a continuous conductor and furnishes a steady current. Iron can be magnetized by galvanism, but not by electricity.

In 1816 Ronalds sent signals by frictional electricity through eight miles of wire at Hammersmith. This same inventor proposed the adoption of an electric telegraph to the Admiralty, and in a volume published on the subject in 1823, remarked that if he "should be proved competent, why should not our kings hold councils at Brighton with their Ministers in London? Why should not our Government govern at Portsmouth almost as promptly as at Downing Street? . . . Let there be electric-conversation offices, communicating with each other all over the kingdom."

Without pausing to trace all the steps of Arago Soemmering, of Schweigger, and others, we may remark that at last, in the early thirties, the elements of modern Telegraphy were ready for some master mind to combine in a single invention.

It is claimed for Professor Morse, an American, that he invented the first electro-magnetic

telegraph while on a passage from Havre to New York in 1832. But no account of this per-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Earliest Advertisement of the Electric Telegraph.

Queen Victoria made use of the wires mentioned in these handbills for her first telegraphic communication with her Ministers in London.

formance was published until 1837, when Schilling, Gauss and Weber, Steinheil, and Wheat-

stone had achieved considerable success in the construction of electric telegraphs. The first message by the Wheatstone-Cooke system was sent between the Euston and Camden Town stations of the London and North-Western Railway on the evening of July 5, 1837.

Morse's contrivance included a marker at one end of a wire, which, as contact was made or broken, conveyed an arbitrary alphabet of dots and strokes, representing definite characters. Wheatstone (whose first patent was taken out in 1837) soon made improvements which greatly simplified his first methods; the number of wires was reduced to two, and thirty letters could be indicated in a minute. A new field for observation was opened up for the world by Wheatstone. He showed that inasmuch as electricity traveled at a speed which would girdle the globe seven or eight times in a second, it could be employed in measuring the rate of motion of projectiles, or regulate the movement of all the clocks in the country. With the proper mechanical accessories a "lady seated in her drawing-room in London might play Beethoven's sonatas on the piano of her friend at Edinburgh; or a ringer in St. Paul's belfry might entertain the frequenters of the Parliament Square with a lively carillon from the Tower of old St. Giles's."

The first example of the commercial application of the electric telegraph was in connection with the Blackwall Railway, opened in 1840. The announcements of departures, of stoppages, of the number of carriages attached, of accidents or causes of delay were regularly transmitted by

electro-magnetic apparatus, placed at each of the five intermediate stations.

Two years later, the system had been adopted on the London and North-Western, South-Western and other lines. It had not been long completed on the Great Western when a striking instance occurred of the service which the new invention was to render to society. A man of respectable exterior took his seat in a first-class carriage at Slough, eighteen miles from Paddington—he was a murderer fleeing from the yet warm body of his victim. The hurrying engine neared the terminus: the desperate man felt certain of his escape; but he had not reckoned on the speed of the telegraph. An alarm had been given at the scene of his crime; quick as a flash the wires bore it to London, describing the man's flight and personal appearance. In three minutes an answer announced the arrival of the train, the identification of the fugitive, and the certainty of his capture.

This, and other similar incidents, naturally created a deep impression on the public mind. On the birth of the new year (1845) a telegram transmitted from Paddington was received at Slough before the old year had expired, there being a sufficient difference of longitude to be marked by the velocity of the mysterious new agent.

We are now so accustomed to the rapid public record of passing events by the newspapers as hardly to understand the patience of the reading world prior to the era of the telegraph.

The first newspaper report received by wire appears to have been of a public meeting at

Portsmouth, during the railway mania of 1845, which created such interest in London that the *Morning Chronicle* printed it an hour or so after the meeting broke up. The other newspapers, receiving their reports by train, which took three hours, followed the example the next day. After this, the proprietors of a Southampton journal resolved to print the Queen's speech without waiting for the railway. The report was transmitted, letter by letter, and the 3,600 letters were set up in type in Southampton two hours after delivery in Parliament. The only limit now was the expense: and news telegrams accordingly began to appear regularly in the press.

The old signaling system or semaphore still lingered on at the Admiralty until 1848, in which year the new electric telegraph was substituted.

Two years before the Electric Telegraph Company had been incorporated, with a central establishment in Lothbury. The premises were amply equipped with all the necessaries of telegraph service; and by means of wires, laid in tubes underground, was connected with all metropolitan railway stations, the Post Office, the head police station in Scotland Yard, the Admiralty, the New Houses of Parliament, Buckingham Palace, and many other public buildings. In addition, communication was made with various places in the Provinces, including the chief towns and seaports. "Electric telegraphs," declared the Parliamentary statute, "shall be open for the sending and receiving of messages by all persons alike, without favor or preference, subject to a prior right of use thereof for the service of Her Majesty and for the purposes of the Com-

pany." A proviso is also made in favor of the Home Secretary of State, who may, on extraordinary occasions, take possession of all the telegraph stations and hold them for a week, with power to continue the occupation, should the commonweal demand it. There were established in Edinburgh, Manchester, Liverpool, Glasgow, Hull, Newcastle, and other towns, subscription news rooms, for the accommodation of the mercantile and professional interests, to which was transmitted by electric telegraph the latest intelligence, including domestic and foreign news; shipping news; the stock, share, corn and other markets; parliamentary intelligence; *London Gazette;* state of the wind and weather from numerous places in England; and the earliest possible news of all important occurrences. Other companies soon followed, to the number of seven or eight; a period of competition set in, and in 1861 the United Kingdom Company established shilling telegrams, without reference to distance. For some years this charge—double what it is at present—was found unremunerative, and at length an agitation sprang up for the acquisition of the whole telegraph system by the Government.

The rise of electric telegraphs in France was at first remarkably sluggish. The reason for this was that the Government had spent a great deal of time and money in developing their system of semaphore telegraphs; and even when they were induced to avail themselves of electricity, it was stipulated that the signals should still be produced by small instruments, similar in principle and construction to Chappe's apparatus. At

length, however, this absurd stipulation was withdrawn, instruments and equipments similar to those in use in England were acquired by the French Government, and by 1847 telegraphs from Paris to Orleans, to Rouen, Lille and Calais were brought into operation.

A curious economical advantage resulting from the new system in France was the saving of locomotive power on the railways; for in accordance with the practice on the French lines, whenever a train was twenty minutes late, an auxiliary engine was despatched to its relief from one station after another along the route. By 1850, 1,500 miles of telegraphs were complete and in progress in France.

It was not long before every country in Europe began gradually to feel the benefit of this wonderful medium of communication. Already in 1850, the ramifications of telegraphs extended from Calais to Moscow, from the Baltic to the Mediterranean. "Already," said one writer, "there is talk of introducing the thought-flasher into that land of wonders—Egypt; to stretch a wire from Cairo to Suez for the service of the overland mail. Who shall say that before the present generation passes away, Downing Street may not be placed in telegraphic *rapport* with Calcutta?"

After this suggestion appeared, progress was so rapid that in 1861 Europe boasted 100,000 miles of telegraphic wire; and in 1865, Downing Street actually was "placed in telegraphic *rapport* with Calcutta."

In the United States, it need hardly be said, the telegraph was from the first most extensively

developed and applied. The lines were in many cases carried across country, regardless of traveled highways, over tracts of sand and swamp, and through the wild primeval wilderness. "Away it stretches—the metallic indicator of intellectual supremacy, traversing regions haunted by the rattlesnake and the alligator—solitudes that re-echo with nocturnal howlings of the wolf and bear." Rapid communication was thus made possible from North to South, East and West, through all the length and breadth of the Republic with a frequency and cheapness long exceeding any other nation. This superiority has, since the establishment of sixpenny telegrams, been transferred to the United Kingdom.

And now we come to telegraphing without wires. It was conjectured by Faraday, Helmholtz and others that light from the sun and electricity were of the same order, only differing in degree, *i.e.* in the lengths of their respective waves. Their velocity through space was the same, namely 186,400 miles a second. Light waves, heat waves and electric waves in traveling from the sun to the earth—a distance so great that an express train traveling sixty miles an hour would take 175 years to accomplish it—reach our earth in eight minutes. These waves cannot travel along nothing: they must have an elastic medium which will transmit them. If the ether be capable of conveying electrical energy from the sun without loss and without intervening wires, it was reasonable to ask: Why cannot some form of instrument be devised which will also send out along the terrestrial ether electrical currents, even in a small way? Air must not

be confounded with ether. One set of vibrations may concern, perhaps, thousands of waves per second, but those in the ether are reckoned by hundreds of millions, hundreds and even thousands of billions per second. For example, if in a thunderstorm, three miles distant, we see a flash of lightning, the light waves in the ether reach the eye at practically the same instant the flash occurred; but the sound-waves of the electrical discharge traveling through air travel only 1,150 feet a second, and so would not reach us for fourteen seconds. In this time the electrical current would have circumvolated the earth at least 100 times. Yet although there is such a wide difference in rapidity between the air and ether waves, yet they bear so much resemblance to each other, as is seen in practical experiments in syntony. Every musician knows that if a violin and a piano be in the same room and are tuned to each other, a note sounded on the violin will find a response in the piano, if the dampers be raised from the strings, by actuating the pedal. In the same manner, in all recent experiments with the Hertzian waves, a system of "tuning" is resorted to, in order to establish perfect unison between the receiving apparatus and the transmitter. So important is this tuning or syntony between waves that the privacy of messages sent and received by wireless telegraphy may be secured by it.

The first to suggest a method of signaling across space without intervening wires was J. B. Lindsay, of Dundee, about 1853. In the following year he patented his invention and conducted experiments in London and Portsmouth, where

he successfully telegraphed without wires across 500 yards of water. After a lapse of thirty-four years, in 1887-88, other experiments were made through the air by direction of Sir W. Preece, who some years later successfully sent messages across a distance of four and a half miles by the use of dynamic electricity. Static electricity was first used by Hertz, when it was found that waves or vibrations passing through a wire set up similar vibrations in the other. These waves vibrate in all directions, and by very delicate receiving instruments it was found possible to gather them up in sufficient strength to repeat their pulsations and record their messages from the transmitter. Mr. Marconi, a young Italian inventor, has been experimenting with this form of communication since 1890, and late in 1902 achieved the signal success of telegraphing without wires across the Atlantic from Cape Breton to Cornwall, and later from Cape Cod to Poldhu, in Cornwall, a distance of 3,000 miles. Other successful systems have been devised by Prof. Slaby and Count d'Arco in Germany, and by Dr. Lee DeForest in the United States. Thus a new method of rapid communication, destined to work mighty changes in commerce and warfare, has been discovered.

The reality of the new science may thus be illustrated: The S.S. *Umbria*, like all the boats of the Cunard line, is fitted with the Marconi system of wireless telegraphy. She set out from New York May 31, 1902, and was soon in mid-ocean. The American ambassador, speaking at a concert on board, could only express a hope that on landing, the news of the conclusion of

war in South Africa might be imparted. He reckoned without science. Late on that night a Marconi message was received giving the news of peace and—the winner of the Derby! It has become a regular experience on the Atlantic boats, at whatever distance from land, to see, as in a London club, the servants carrying round telegrams, and calling the name of the recipients. The lonely sea has thus lost another of its terrors.

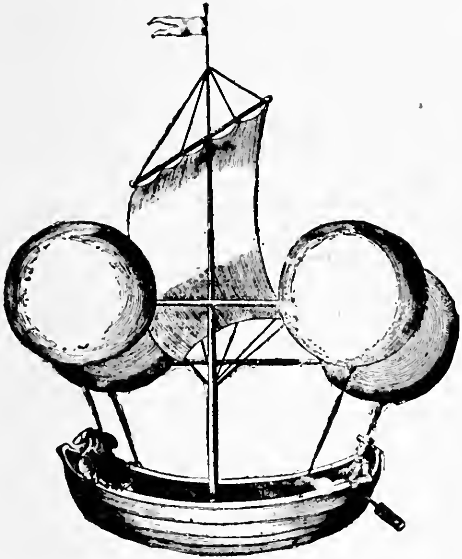
CHAPTER VI

AERIAL NAVIGATION—HOMING PIGEONS

Of all forms of locomotion the palm for speed must be given to the aerial variety, although it is true that as a reliable means of rapid transit aerial navigation has advanced scarcely more than a single step since the invention of balloons more than a century ago. Yet it is equally true that during this time a large number of voyages through the air have been successfully carried out by intrepid aeronauts. These certainly serve to show how great will be the boon conferred on mankind when some means of guidance of balloons or airships is discovered which will stand all tests. Already MM. Krebs and Renard, and Santos-Dumont and others have demonstrated that it is possible to navigate an airship in favorable weather in precisely the direction desired; but the form of locomotion can never become of economic value until the safety of the machine and its occupants is better insured than it is at present.

Franklin said of the science of aerostation: "It is an infant, but it will grow."

The discoveries and inventions relating to the uses which have hitherto been made of the at-



An Airship Designed by Francis Lana, of Barcelona, 1760.

mosphere and the mathematical deductions which so clearly teach us to hope for the practicability of aerial navigation, form a most interesting story. But in these pages we must confine ourselves to a few of the actual achievements of aeronauts in rapid traveling through space.

The earliest recorded instance appears in the

Ministre's History of Lyons: "Toward the end of Charlemagne's reign, certain persons who lived near Mount Pilate, in Switzerland, knowing by what means pretended sorcerers traveled through the air, resolved to try the experiment, and compelled some poor people to ascend in an aerostat. This descended in the town of Lyons, where they were immediately hurried to prison, the mob desiring their death as sorcerers. The judges condemned them to be burned; but the Bishop Agobard suspended the execution, and sent for them to his palace that he might question them."

When the good prelate had heard their tale of the singular manner in which they had traveled so far in so incredibly brief space of time, he pardoned them, although himself incredulous. Posterity, which reads this story, may likewise share the bishop's incredulity. Francis Lana, of Barcelona, was said to have invented an aerial machine in 1670, but it failed to travel: wherefore we may wisely pass over a host of similar relations, as well as all the aerostatic experiments up to the invention of the balloon by the brothers Montgolfier in 1783.

Nearly ten months had elapsed since this first aerostatic experiment, when a young chemist, Pilatre de Rozier, offered himself as the first voyager in the newly invented aerial machine. The first to make an aerial voyage (in the horizontal sense) in England was a Neapolitan, Vincent Lunardi, on September 15, 1784, he traveled from the Artillery Ground, Moorfields, to Standon, near Ware, Herts, a distance of thirty miles. The journey was not remarkable

The First Aerial Voyage.

for speed, as it occupied two hours and a quarter, including a stoppage at South Mimms. "The departure was most exciting." "Perhaps," observed the *Morning Post* of the following day, "the English nation never witnessed upon any occasion whatever such a number of persons collected together and so loftily displayed; not a plain or an eminence, a window or a roof, a chimney or a steeple but were prodigiously thronged." Lunardi became a popular hero: was presented to the King, and made a honorary member of several learned societies.

Four days later, in Paris, the brothers Robert performed a journey in the air from Paris to Arras, 150 miles, a portion of the trip being made at the rate of twenty-four miles an hour. This journey is remarkable as being probably the fastest ever made by human beings for such a distance, up to that era.

But this record of speed was soon to be broken. Sadler, an English aeronaut, ascended from Oxford on October 12th of the same year, going fourteen miles in forty-one minutes, descending, and, after considerable delay, proceeding to Romsey, in Hampshire, at the rate of twenty-nine miles an hour.

A memorable aerial voyage—the first across the English Channel—took place January 7, 1785. Blanchard, a Frenchman, and Dr. Jeffries, an American, pushed off in a balloon from the cliff at Dover at 1 P.M. The weight being too great for the power of the balloon, some time was consumed in discharging ballast. When they rose, they continued vertically, so that properly the journey did not begin until half-

past one. Exactly at three o'clock, after an exciting voyage, during which they had been obliged to throw overboard their very clothes, they passed over the high ground midway between Cape Blanc Nez and Calais. They descended in the Forest of Guines; the freedom of Calais was bestowed upon Blanchard, and a monument erected to mark the spot where the pair alighted.

It was in an attempt to emulate this exploit that a few months later Pilatre de Rozier and his friend Romaine lost their lives.

The maximum of speed had not yet been attained—and Lunardi, October 5, 1785, was to surpass his own record and all of his contemporaries. Rising, at 3.45 P.M., from Heriot's Gardens, Edinburgh, he says: "The city of Glasgow I could plainly distinguish, also the town of Paisley, and both shores of the Forth; but my attention was now diverted by finding myself immediately over the Firth of Forth, at an altitude of 2,000 feet. . . . At 4.20 I descended at Ceres, after a voyage of forty-six miles, thirty-six being over water, and was conveyed in triumph to the town of Cupar." Thus Lunardi had accomplished forty-six miles in thirty-five minutes, which is a speed almost equaling the fastest that has ever been done on a railway. A longer journey was subsequently done by Lunardi, leaving Glasgow at 1.55 P.M., and in precisely two hours arriving at Alemoor, Selkirkshire, 110 miles, including a halt of some minutes in the hills.

A voyage notable for its remarkable rapidity was executed by Garnerin, June 28, 1802, in

company with Captain Snowdon, R.N. They departed from Chelsea Gardens and came down near Colchester, sixty miles in forty-five minutes. On July 5th Garnerin ascended from Marylebone and descended at Chingford, seventeen miles, in fifteen minutes, and attained also during this interval a height of 7,800 feet.

But a more notable voyage was to be made by the French aeronaut Garnerin, in the balloon commemorating the coronation of Napoleon I. At 11 P.M. on December 16, 1804, Garnerin allowed his colossal machine to rise from the square in front of Notre Dame, Paris. Twenty hours later it had passed through France and Italy, over St. Peter's at Rome and the Vatican, to descend into Lake Bracciano. It had traversed a distance of 800 miles. The coronation balloon was subsequently suspended in a corridor of the Vatican, where it remained until 1814.

No further notable aerial voyages are recorded until October 7, 1811, when Sadler and Burcham left Birmingham at 2.20 P.M. and by 4 P.M. had made a flight of 112 miles. They finally alighted near Boston, *via* Leicester, Market Deeping, and Peterborough.

Sadler was the first to attempt to cross the Irish Channel, ascending from the lawn of Belvedere House, Dublin, October 1, 1812, and receiving his flag from the Duke of Richmond. But he found himself precipitated into the sea *en route*, the feat not being accomplished until 1817, when the same aeronaut's son, Windham Sadler, traveled from Portobello Barracks, Dublin, at 1.20 P.M. on June 22d, and at 6.45 alighted a mile south of Holyhead.

Soon after this the famous Charles Green began his long series of intrepid aerial journeys, many of which were remarkable for distance and speed. One of these was undertaken in a storm, from Newbury, Berkshire, to Crawley, Surrey, fifty-eight miles, in an hour and a half, which was rapid time for 1827, considering that the one railway then in England could only boast of twenty miles an hour. But by far the greater portion of Green's fame must rest upon his voyage from London to Weilburg in the great Nassau balloon. This took place in 1836, the start being from the Vauxhall Gardens at 1.30 P.M., November 17th. At twelve minutes to three the Medway was crossed, and Canterbury at five minutes past four. A curious circumstance is that the aerostat passed several coaches *en route*, going at the fastest rate possible and was cheered by their occupants. The railway was not then opened, and the fast time to Canterbury by coach was five and a half hours. At 4.48, Green (who was accompanied by Monck Mason) gained the Channel, and at ten minutes to six o'clock had effected a crossing in safety, two miles from Calais. As the night progressed they were, of course, totally without landmarks and so could not judge of their speed. "In this manner," writes Mason, "did we traverse with rapid strides a large and interesting portion of the European continent, embracing within our horizon an immense succession of towns and villages, whereof those which occurred during the earlier part of the night, the presence of their artificial lights alone enabled us to distinguish."

It was at 7.30 on the following morning that

the descent took place, so that the duration of the voyage was exactly eighteen hours. "The first question, 'Where are we?' was speedily answered, 'In the Duchy of Nassau, about two leagues from the town of Weilburg.' The second was theirs, 'Where do you come from?' 'From London, which we left yesterday morning.' The astonishment of the inhabitants at this declaration may be imagined."

To reach Weilburg from the British capital in the year 1836 by the fastest coaches and steamer would have taken three days. Green and Mason had done it by balloon—a distance of more than 500 miles—in eighteen hours. A considerable portion of five kingdoms, England, France, Belgium, Prussia, and the Duchy of Nassau; a long succession of cities, including London, Rochester, Canterbury, Dover, Calais, Cassel, Ypres, Courtray, Lille, Oudenarde, Tournay, Brussels, with Waterloo and Jenmapes, Namur, Liege, Spa and Coblentz were all brought within the compass of their horizon. When one reflects on the smoothness of the traveling, its quiet and absence of distracting apparatus, we may safely regard this long journey as an ideal transit and among the most remarkable for speed which ever took place prior to the establishment of railways.

In June, 1841, Wise, an American aeronaut, set out from Danville, Pa., at 2.35 P.M., and arrived at Morgantown, seventy miles distant, at 4.25, having in reality traveled a tortuous course at the rate of fifty-five miles an hour. In the same year Green traveled twenty miles in twenty minutes from Chelsea to Rainham, Essex. A few years later Coxwell traveled through the air from

Berlin to Dantzig, 170 miles, in three hours and ten minutes.

A remarkable instance of speed in aerial transit was afforded in 1849 by M. Arban, who crossed the Alps from Marseilles to Turin, a distance of 400 miles in eight hours. This record between the two cities never has been broken. The speed, however, was equaled in Coxwell's journey in 1857 from North Woolwich to Tavistock, Devon, 250 miles, in five hours. "It was some time before the particulars of the journey obtained credence. At Sidmouth the alarm-bell was rung by the night watchman; but before the inhabitants were astir the balloon was out of sight and the man laughed at, until the Devonshire papers were published with an account of the voyage." The aeronauts walked into the town of Tavistock, and put up at the Queen's Hotel, where they had difficulty in persuading the worthy host that they had been in London the night before. A shorter journey from Winchester to Harrow, seventy-six miles, was in 1862 accomplished in sixty-six minutes by Colonel M'Donald and six officers of the Rifle Depôt Battalion, accompanied by Coxwell. For most of the voyage the velocity was not less than seventy miles an hour.

We now come to one of the most celebrated of modern aerial voyages, that of Nadar's "Géant" in 1863 from Paris to Nienburg, Hanover. This famous journey was preceded by a brief one on October 4th, in which no fewer than fifteen persons were carried in the monster car. The balloon held 6,098 meters of gas enclosed in 20,000 meters of silk, and was the largest ever

constructed. It descended on this occasion two leagues from Neaux, and a fortnight later, with nine passengers, reascended at 5 P.M. from the Champ de Mars. At half-past eight it was over Compeigne, seventy-eight miles from Paris. Nothing more was heard of the balloon until a second telegram was received in Paris stating that Nadar's giant balloon passed over Erquelines, on the Belgian frontier, at midnight on Sunday. The airship was moving not far from the ground, and the customs officer called out to know if there was anything on which duty should be paid! No attention was paid to the question, and the balloon kept on its way toward the German frontier. At midnight the travelers were over Holland, and later crossed the Zuyder Zee. At 7.15 they were journeying through Westphalia, crossing the river Ems, and at length returning to Hanover, a little above Osnaburgh. The balloon was on its way toward Hamburg and the Baltic when it was thought wise to effect a descent.

The descent was of a most exciting and desperate character, for the wind was blowing at a high rate, and the balloon was moving through the air at sixty miles an hour. The car grazed the earth and began dragging over walls, fences, houses, stones, and ponds. One of the passengers, Jules Godard, then tried to accomplish an act of sublime heroism. He clambered up into the netting, and although three times falling, reached the cord of the valve, opened it, and the gas having a way of escape the monster ceased to rise, but it still shot along in a horizontal line with prodigious rapidity. One after another the

passengers jumped, not without injury, from the car, and soon found that they had arrived in the vicinity of Rethern in Hanover. In seventeen hours they had traveled 250 leagues, while for a single hour they had sustained a speed of at least ninety miles.

The siege of Paris offered to the professors of aerial navigation a signal opportunity to apply their system.

At the outbreak of the Franco-Prussian War in July, 1870, there were in Paris many experienced aeronauts, including Tissandier, de Touvielle, Nadar, Jules Durouf (about whom we shall speak later) and Eugene Godard—who had made no fewer than 800 ascents. The subject of military ballooning was naturally raised, and received a lukewarm support from the Imperial Government, which was far too disturbed seriously to consider any scientific matter, even the true science of the commissariat in war-time. Before anything could be arranged, there came the disaster of Sedan, which was followed in a few days by the close investment of Paris. The new Government at once addressed themselves to the aeronauts, with a view to opening up aerial communication with the exterior country. Six balloons were overhauled, all in indifferent condition, the worst being the one Napoleon III. had intended for Solferino, but which had arrived on the scene of the battle a day too late. M. Tissandier tells us that nobody seems to have known how to repair this balloon, known as *L'Imperial.* However, they were all got together, the besieged Parisians hailing the prospect with the joy of children. Here at last was a noteworthy chance of putting

into execution the very idea for which Montgolfier, the inventor of the balloon, had really intended his invention.

The first ascent of the siege was made by M. Durouf on September 23d. He carried a large number of despatches, and after a three hours' journey landed safely near Evreux. He was followed on the 21st by M. Mangin; on the 29th by Godard, jun., and on the 30th by Gaston Tissandier, who has given us a spirited account of his voyage.

The success of these aeronauts in escaping from the capital and the hands of the Prussians encouraged the Government to establish a balloon post on a regular system. Immediate steps were taken for the manufacture of a large number of balloons, under specific conditions, as rapidly as possible. Making the vessels proved, however, an easier task than finding captains for them. Experienced aeronauts were few, and it must be remembered that when once they left Paris there was no returning. That was the radical fault of balloons; one could not elect the place of one's descent. In this emergency it was decided to invite the assistance of such sailors as there were in the capital, as belonging to a class whose training had rendered them familiar with operations and dangers not dissimilar from ballooning. The appeal met with a satisfactory response; many excellent mariners offered their services, they were given all possible instructions and a large number of successful ascents were carried out by these brave French tars. The remark of one of them deserves to be memorable: "Our topsail is high, sir, and difficult to reef; but we can sail,

all the same, and, please God, we'll arrive in port."

The plan of employing acrobats from the Hippodrome was attended with less success. In several instances we are told they directed their skill, when in a tight place, to slipping down the guide-rope to earth, leaving the passengers and despatches to look after themselves. But on the whole the balloon service was distinguished by singular ability and precision. From September to January sixty-four balloons were sent off, and of these fifty-seven fulfilled their mission, and the despatches reached their destination. The total number of persons who left Paris was 155, the weight of the despatches was nine tons, and the number of letters 3,000,000. As for the speed of transit, it varied from twenty to fifty miles an hour, and in one instance as high as eighty miles.

Gambetta left by the *Armand Barbes* (every balloon had of course a name) on October 7th. When at too low an altitude he was immediately fired on by the Prussians and narrowly escaped being hit by a bullet.

On October 27th the *Bretagne* fell, owing to bad management, into the hands of the enemy near Verdun; on November 4th the *Galilee* had a similar fate near Chartres; and on the 12th the *Daguerre* was shot at, brought down and seized a few leagues from Paris. The loss of three balloons within a little more than a fortnight alarmed the Government. It was obvious that the vigilance of the enemy had been aroused, and whenever a balloon was seen advices were telegraphed along its probable line of flight, and the swiftest Uhlans were put on the alert in the

hope of capturing it. The danger had vastly increased, since a new rifled gun of enormous range had been made by Krupp for the purpose of firing shells at the aerial transports. One of these was about this time set up at Versailles. For these reasons the Government resolved that in future balloon departures should take place at night. At the same time the darkness added greatly to the difficulties of the voyage, and several of these nocturnal ascents were attended with singular adventures.

About midnight, on November 24th, the *Ville d'Orleans* rose from Paris with an aeronaut and one passenger. The wind blew from the north and it was hoped the balloon would descend near Tours. But in a short time the voyagers heard a sound below them which caused them both deep apprehension; it was the lashing of breakers on the shore. At the time of this discovery they were in a thick mist; when at daybreak this cleared they found themselves suspended over the sea, out of sight of land. Several vessels were perceived and to these they tried to signal, but were not answered. One vessel, indeed, responded; but it was by firing at them. Scudding now rapidly to the north they were giving themselves up for lost when they came in sight of land to the eastward. Before they could gain it they descended rapidly from loss of gas, their ballast being gone they were obliged in despair to throw out a bag of despatches. This expedient saved them; the balloon rose, encountering a westerly current which carried them to shore. What part of the world they were in at their descent they had no notion; the ground was

covered with snow, they saw no inhabitants, and being overcome with fatigue and hunger, both fainted on getting out of the car. On recovering they walked through the snow with great exertion, and after a painful journey of several hours passed the night in a shed. In the morning a couple of woodmen informed them, by means of signs and a box of matches marked Christiania, that they were in Norway. Their speed was over fifty miles an hour for a number of hours.

A week later, on November 30th, two fateful ascents from beleaguered Paris were made. The *Jacquard* rose at 11 P.M. in charge of a sailor named Prince, whose new-found aeronautic zeal was so great that as the ropes parted he cried out: "Je veux faire un immense voyage; on parlera de mon ascension." He was not, alas, to be balked of his ambition. Driven by a southeasterly wind he passed over the English Channel, where he was seen by some English vessels. While over the vicinity of the Lizard he dropped his despatches, some of which were afterward picked up on the rocks. Thus lightened the balloon rose to a great height, disappeared over the Atlantic billows and was never heard of again.

The second balloon, the *Jules Favre*, started at half-past eleven with two passengers. Only by a miracle did it escape the fate of the *Jacquard*. The wind blew from the north and the aeronauts fancied they were on their way to Lyons. Long enveloped in fog, they emerged at daybreak and saw beneath them an island which they supposed to be in a river. They were grossly deceived; it was Hoedic, in the Atlantic! They were driving furiously out to sea; but in front of them lay,

as a forlorn hope, the larger island of Bell-Isle. It was seen that they would have to pass one end of it where it was very narrow, and that they must either land on this strip of land or be lost. They tore the valve open with frantic energy, caused the balloon to descend some 1,000 feet in a few minutes, and luckily succeeded in striking the land. Albeit the shock was terrific; three times did the balloon bound into the air, and at last caught against a wall, precipitating the occupants of the car to the earth. They were badly injured, but received great attention from the people of the neighborhood. The father of General Trochu resided there, and ordered them to be brought to his house.

On December 15th the *Ville de Paris* was so unlucky as to fall at Wertzlar, in Prussia; and four days later the *General Chanzy* was made captive at Rothenburg, in Bavaria. On the morning of January 28th the *Richard Wallace*, which rose from Paris the previous night, was observed at La Rochelle approaching the sea and almost touching the ground. The people shouted to the aeronaut to descend, but instead of doing so, he threw out a sack of ballast, rose to a great height and soon disappeared in the western horizon. Doubtless, the poor fellow had lost his senses on seeing the danger which confronted him. This almost completes the story of the ballooning during the siege of Paris. It was the last ascent but one; that on the next day bore intelligence to the provinces of the conclusion of an armistice.

These aerial voyages had solved the problem of communication from Paris outward. The

other problem of communication inward from the Provinces was hardly less important and much more difficult. It required a particular direction of current, and although M. Tissandier made several attempts he failed, and the return of the balloons was abandoned as impossible. Of the projects which were offered to the Government to encompass the desired end, some were among the wildest and most visionary that ever entered the brain of man. One balloon took out some trained dogs, which, it was hoped, would find their way back again, but they never reappeared.

The actual method by which the difficulty was solved deserves, we think, a place in a work dealing with modern locomotion. The return post was effected by means of carrier pigeons, which, having been taken out of Paris in balloons, were let loose in the Provinces to find their way home. There existed in Paris a "Société Colombophile," and after the departure of the first balloon the leading spirits of this body approached General Trochu, and proposed that an attempt should be made to combine the outward balloon post with a return service by pigeons. The second balloon carried three birds, which came safely back six hours later, with news from the aeronauts. The return of eighteen more despatched in following days confirmed the practicability of the scheme. Thereupon, the service was regularly organized and was carried on with a fair amount of success throughout the investment of the capital by the enemy. As the despatches were required to be very small and light, recourse was had to mi-

croscopic photography. By this means sixteen folio pages of print (32,000 words) were reduced to a pellicule two inches long, one and a quarter inches wide, and weighing about three-quarters of a grain! The messages were destined for residents of Paris, and came from all over France. Here are a few samples:

DEPECHES A DISTRIBUER AUX DESTINATAIRES.

Pau, 26 Janvier.—A Tocher, Rue Chausée d'Antin. Madeleine accouché heureusement hier, Bien beau garçon.

Biarritz, 1 Fevrier.—A. Martin 68 Rue Petites Ecuries. Sommes à Biarritz, bebé completement remis, embrasse papa, doloureusement impassionés événements.

A. Tant.—Besoin d'argent, demande Masquier.

A. Perier.—Tout parfaitement bien; trouverons charbon dans cave.

Each pigeon carried twenty of these tiny gelatine leaves, carefully rolled up and placed in a quill. They contained sufficient printed matter to fill a large volume, and yet the weight of the whole was only fifteen grains. When the bird arrived at his cot in Paris, his precious little bundle was taken to the Government office, the quill was then cut open and the gelatine leaves extracted. Placed in an enlarging optical apparatus, similar to a magic lantern, the messages were thrown on a screen, copied from thence, and sent to their destination. The charge was fifty centimes a word. The despatches were not entrusted to one pigeon, but repeated by others, in order to provide against accidents, which were very common. The Prussians were powerless against the winged messengers, although an attempt was made to chase them with birds

of prey; but dense fogs and severe cold played havoc with the birds. There were sent out of Paris 363 pigeons, of which only fifty-seven returned, some having been absent a long time.

Such is a brief narration of this aerial post. It was, beyond question, a marked success. Although it could not save France or her capital, yet it was an immense boon to the besieged, for it established, during the whole of the siege, that communication with the exterior which would otherwise have been impossible. Had the cause of the French been less desperate, the strategic advantage this correspondence would have imparted might have even turned the scale against the enemy.

This suggests to us a reference to the speed attained by pigeons as agents of rapid transit.

The idea that fast homing pigeons cover a mile a minute for a considerable distance must, like the tradition that Eclipse once accomplished that feat, be finally abandoned. In no part of Great Britain are the breeding and training of these birds brought to greater perfection than at Sheffield, and if its champions cannot travel at the pace of express trains, or approaching such speed, it is not probable other localities are better supplied. In a competition early in 1902 from Banbury to Sheffield, a distance of ninety-two miles, nearly 300 birds were flown with a strong wind behind them. All other circumstances being propitious, and the birds being selected for speed from a very much larger number, it was anticipated that the winner's time would be exceptionally fast. Whether that was the case is not recorded, but the official timing

gave the leading bird an average velocity of only about two-thirds of a mile per minute, with several others in pretty close attendance. Some time w lost, no doubt, after the start before

Santos-Dumont Rounding the Eiffel Tower in His Airship.

the direct line for home was hit on, and also at the finish before alighting. But even when full allowance is made for these delays, it does not go far to make up the difference between 1,161 yards and 1,760 yards a minute. Still, since very few of the birds liberated at Banbury failed to arrive at their destinations, the pigeon-

post presents the additional advantage of a large degree of security. We have seen that when several of these birds were entrusted in wartime with the same message, some were sure to reach their destination, even if the enemy were ever so vigilant.

Subsequent developments in the history of aerial navigation are speedily narrated. On the conclusion of the Franco-Prussian War, M. Dupuy de Lome, naval architect to the French Government, produced an elongated balloon, 120 feet in length and fifty feet in diameter, containing 120,000 cubic feet of hydrogen. It was actuated by a screw propeller, and with it the inventor made a journey of some ninety miles, but without being able to control the direction. Other similarly shaped aerostats (to which the name airships has latterly been applied) followed, until in 1884 MM. Krebs and Renard of the French army accomplished for the first time a circular voyage, returning from the point of departure after a considerable aerial flight. They did so, however, under the most favorable atmospheric conditions, the car was of great lightness and the electric dynamo operating the screw was of eight horse-power. Attempts to imitate this feat under less perfect conditions failed, until in 1901 Alberto Santos-Dumont, a young Brazilian experimenter, circumnavigated the Eiffel Tower in an airship of his own construction. But still the problem of a dirigible balloon is far from being solved, and adverse climatic conditions render the feat a highly dangerous, if not an impossible one. There are many who believe that the possibilities of the balloon have been

exhausted, and that the future locomotion through the air will only be made possible by flying machines constructed on the kite or aeroplane principle.

CHAPTER VII

OCEAN TELEGRAPHY — THE TELEPHONE — PNEUMATIC TUBES—POSTAL SYSTEMS

"THE restless spirit of modern invention, not content with guiding the mysterious power of electricity, both above and beneath the surface of the earth, proposes next to join the shores of England and France by means of a submarine telegraph. That such an undertaking is possible there is but little doubt; but the question is, would it be worth while to attempt to carry it out?" The author of the foregoing in a work on Telegraphs, published in 1848, decides in the negative, for, says he, "the injuries to which the wires would be subject appear to create almost an insuperable objection to this plan being carried out on a large scale."

As yet we have seen that the speediest communication between any points separated by the sea was by means of the fast steamers, which had now replaced the fast sailing ships of the beginning of the century. Dover and Calais, as well as London and New York, were solely dependent on steam to convey at the most rapid rate tidings upon which the fate of nations might hang.

In 1845 an American newspaper boldly pre-

dicted that the Atlantic would one day be spanned by an electric wire, to interchange thought between the two great English-speaking nations. The idea was derided as extravagant, but many inventors had been experimenting in submarine telegraphy, and in 1847 there came the actual submarine line in Portsmouth Harbor. The success of this led to projects for similar wires or cables, and three years later, on August 28th, after certain preliminaries, the *Goliah* steamer started from Dover with a huge reel on her deck, containing twenty-five miles of wire, coated with gutta percha, which was slowly and gradually unwound and submerged in the water of the Channel. That same evening a message flashed from under the sea to the horse-box which served as a temporary office on the English coast: "We are all safe at Cape Grisnez: how are you?" Thus international communication by electricity was achieved; and although it was soon interrupted by the frailty of the cable, which broke against the rocks, yet another year saw it partake of a solid and permanent character. At the outset the new method of communication was only used for the transmission of Stock Exchange intelligence; but on November 21, 1851, the political news from Paris published by the *Times* demonstrated in striking fashion what a valuable power had now been developed.

Private messages (at a fixed rate of charge) began to be sent, and early in 1852 London was placed in direct telegraphic communication with nearly all the chief cities of the Continent, *via* this single cable. Prior to this year the an-

nouncement of the death of a monarch or prime minister, the overthrow of a State or army, might have been transmitted under exceptionally favorable circumstances from the English to the French capital by means of the signaling telegraph in a comparatively short space of time —say, in a few hours. But to the public generally, and for the despatch of messages of merely private moment, the only agent was steam and the post, and this agent required in 1850, 21 hours to travel between London and Paris, 52 hours between London and Berlin, and six days between London and St. Petersburg. In 1853 a private message from Windsor was delivered in Paris in two and a half minutes.

In the previous year Ireland had been linked to England by a marine cable between Holyhead and Howth; submarine cable companies began to spring up in all directions in that year, and lines were soon laid in great number all over Europe, even as far as the Black Sea and the Red Sea. Many of these were at work when the magnificent idea presented itself of a cable across the vast stretch of the Atlantic Ocean. Already, in 1851, a plan was formed for connecting Newfoundland and the Canadian Maritime Provinces with America, and two years later the work was begun. Financial difficulties, however, overtook the project, and it was not until Mr. Cyrus W. Field lent his energy, his counsels, and his wealth to the major task of spanning the ocean that this part of the work was completed.

On August 7, 1857, the two ships carrying the great Atlantic cable left the harbor of

Valentia, Ireland. There was no ship in the world at that time (for the *Great Eastern* was unfinished) capable of carrying the whole 2,500 miles of cable, which was to stretch to Trinity Bay, Newfoundland. The British Government, therefore, lent the *Agamemnon*, and the United States Government the *Niagara*, to divide the work. The shore-end was landed and received with ceremony by the Lord-Lieutenant of Ireland on the Valentia beach, he expatiating on the fervent hope of establishing "a new material link between the Old World and the New." But the enterprise was destined to temporary failure: the cable broke and the ships returned. After a disheartening delay, a new plan was decided upon. The two ships steamed out together into mid-ocean, where the two cables were spliced and submerged, and then each ship began steaming, one east and the other west. But they had not proceeded far when the cable snapped again; again it was spliced, and once more was it broken, this time in two places. Thus there lay at the bottom of the ocean 144 miles of cable and the whole rendered worse than useless. Nevertheless, the projectors were plucky men; they resolved to try again, and the third Atlantic cable-laying expedition met with success—a temporary success, it is true—and the first lightning message sped across the Atlantic on August 6, 1858. Ten days later Queen Victoria cabled the following message, which took but sixty-seven minutes in transmission over 4,000 miles from London to Washington:—

"To the President of the United States. The

Queen desires to congratulate the President on the successful completion of this great international work, in which the Queen has taken the deepest interest.

"The Queen is convinced that the President will join with her in fervently hoping that the electric cable which now connects Great Britain with the United States, will prove an additional link between the nations whose friendship is founded upon their common interest and reciprocal esteem.

"The Queen has much pleasure in communicating with the President, and renewing to him her wishes for the prosperity of the United States."

President Buchanan replied in a similar spirit, declaring that the new enterprise was a "triumph more glorious, because far more useful to mankind, than was ever won by conqueror on the field of battle," and trusting that "even in the midst of hostilities, the cable would be regarded as neutral by all nations." The rejoicings over the cable of 1858 were great; but, alas, they were speedily cut short. The electric impulses became weak, and gradually failed after having conveyed a total of 400 messages between the two hemispheres—the last word transmitted being—curious to tell—"Forward."

For five years following, no further capital was forthcoming to make another attempt. But in 1865 a company was organized; this time the cable made heavier, and the whole length, 2,300 miles, was shipped on board a single vessel, the *Great Eastern.* Still again, when the vessel was 1,064 miles from Valentia, the cable broke, owing

to an accidental strain, and after a futile attempt to recover it from the bottom of the sea, it was abandoned for the season. In the following year, another line was at last successfully laid by the *Great Eastern*, the former cable recovered, and thus the Old World and the New were permanently joined together in an intellectual bond.

Its success led to other cable systems. In 1869 a French company laid a line from Brest to St. Pierre, an island off Newfoundland; in 1873 a cable was laid from Lisbon to Pernambuco, in South America. Two other Atlantic cables were laid in 1874 and 1875; and several others since. The Pacific Ocean had to wait longer for a cable. The British Pacific cable from Vancouver, British Columbia, to Sydney, Australia, *via* Fanning Island and the Fijis, was opened in 1902. The new cable to connect San Francisco with Manila, *via* Hawaii, the Midway Islands, and Guam, was completed as far as Honolulu in December of the same year and will be opened for service before the end of 1903, bridging the vast expanse between North America and Asia and Australia, thus girdling the earth with wire.

As a means of rapid communication—rivaling even the telegraph—a place must be found in these pages for the telephone, whose introduction into Europe dates only from 1877.

The idea of transmitting sound to a distance may be traced back to remote antiquity; its first practical expression was found in the speaking-tube, and, in more modern times, in the string telephone.

In 1667 Robert Hooke relates how by the aid of a tightly drawn wire, bent in many angles,

he conveyed sound to a very considerable distance.

"'Tis not impossible," he writes, "to hear a whisper at a furlongs distance, it having already been done; and perhaps the nature of the thing would not make it more impossible, that furlong should be ten times multiplied. And though some famous authors have affirmed it impossible to hear through the thinnest plate of Muscovy glass; yet I know a way, by which 'tis easy enough to hear one speak through a wall a yard thick. It has not yet been thoroughly examined how far Otacousticons may be improved, nor what other ways there may be of quickening our hearing, or conveying sound through other bodies than the air." He assures the reader that he has "by the help of a distended wire propagated the sound to a very considerable distance in an instant."

Again, in the *Repository of Arts*, September 1, 1821, there is a description of an instrument invented by the electrician, Wheatstone, and called a "telephone." "Who knows but by this means the music of an opera performed at the King's Theatre may ere long be simultaneously enjoyed at Hanover Square Rooms, the City of London Tavern, and even at the Horn's Tavern at Kennington, the sounds traveling like gas through snug conductors from the main laboratory of harmony in the Haymarket to distant parts of the metropolis? . . . And if music be capable of being thus conducted, perhaps words of speech may be susceptible of the same means of propagation."

Sixteen years later Page, an American, found

that a magnetic bar would emit sounds when exposed to rapid alternate magnetizations and demagnetizations. By rapidly approaching the poles of a horseshoe magnet to a flat spiral coil traversed by a current, he obtained a sound termed the "magnetic tick." De la Rive, Gassiot, and Marrian remarked the same phenomenon in a soft iron bar surrounded by a helix, at the moment that this helix was traversed by a current. When these vibrations become frequently interrupted, they gave rise to a distinct sound of considerable intensity, and when the interruptions were sufficiently rhythmic and rapid, a musical note ensued.

Charles Bourseul, a Frenchman, who in 1854 published a pamphlet on the electric transmission of speech, foresaw clearly to what all this would lead. "Suppose," he says, "that a man speaks near a movable disk sufficiently pliable to lose none of the vibrations of the voice, that this disk alternately makes and breaks the currents from a battery, you may have at a distance another disk which will simultaneously execute the same vibrations. . . . It is certain that in the more or less distant future speech will be transmitted by electricity."

A few years afterward Philip Reis began his experiments, and in 1868 actually succeeded in constructing a working telephone by means of the galvanic current. It was, however, principally intended to reproduce musical sounds, and although it did convey the human voice, its powers of transmission were of a limited order. Improvements in the musical telephone were made by succeeding inventors; but it was not

until 1876, when Alexander Graham Bell and Elisha Gray, working separately and without collusion, each produced a speaking telephone, that the dream of articulating telephone became realized.

Strange to relate, both inventors applied for patents on the same day, February 14th. The question of priority led to a celebrated law-suit, and ended in a compromise, one company taking up the patents of both inventors. Bell, however, had made important developments in his instrument, while Gray did but little to improve his invention after applying for a patent. As every one is aware, a telephone consists of a transmitter and a receiver, the former being the instrument into which words are spoken, the latter the instrument which is applied to the ear. The receiver has remained virtually the same as described in Bell's patent, but this is not the case with the transmitter, which is to-day another device altogether. In lieu of the original magnetic telephone, the carbon transmitter, involving the use of a battery, is now universally employed. This invention is due to Edison, who devised it in 1877, soon after the first Bell telephone was made. It was subsequently replaced by the microphone of Hughes.

The lines used for telephone purposes are, so far as erection, interment submersion, and mode of insulation are concerned, about the same as ordinary telegraphs. The vast superiority of copper wire to iron for long circuits is shown by the fact that Rysselburg and others have spoken clearly to a distance of over 1,000 miles through a copper wire insulated on poles, whereas Preece

could not work a similar line of iron wire between London and Manchester.

Telephones are now in every city in the world, and have in many become a necessity of daily life, on its social as well as on its economic side.

The new Government telephone system was inaugurated in London in 1902.

Another form of rapid despatch controlled by the Post Office, from which great results in the carriage of human freight is still sometimes anticipated, is that of the pneumatic tube. The transport of written messages by the agency of air-pressure was introduced in 1853 by Latimer Clark between the Central and Stock Exchange telegraph stations in London. These stations were connected by a tube one and one-half inches in diameter and 220 yards long. Receptacles containing batches of telegrams, getting piston-wise in the tube, were sucked through it by the production of a partial vacuum at one end. In 1858 Varley introduced compressed air to be used in conjunction with the vacuum principle for the purpose of returning messages along the same tube. The system grew in the hands of the Post Office, until there are now in London alone some forty miles of pneumatic tubes. In addition to its use for postal and telegraphic purposes, the pneumatic despatch is considerably employed for internal communication in offices, hotels, etc., and also in shops for the transport of money and bills between the cashier's desk and the counters. As to the time taken in transit, an ordinary "carrier" weighs two and three-quarter ounces and holds about a dozen despatches. With a pressure of ten pounds per square inch, or a

vacuum of seven pounds, one minute is required for a length of 1,000 yards, and five and one-half minutes for a length of 3,000 yards. In Paris, where the pneumatic system dates from 1866, large areas of the city have been covered by pneumatic circuits made up of iron pipes, round which long trains of "carriers" are despatched at intervals of fifteen minutes. A similar arrangement is also followed in Berlin and Vienna and in the cities of the United States. Notwithstanding all the developments which have taken place, however, in other departments of rapid locomotion, the pneumatic despatch has made comparatively few strides, and the application of its principle on a large scale is a problem for the future.

Before concluding this chapter it may be worth while to glance back at the conditions which formerly obtained at the Post Office.

Under the postal regime of 1820 it took as long a time to convey a letter from Kingsland to Camberwell, a distance of only five miles, as some twenty years later sufficed for its transmission from the Scottish to the English capital.

The mails were first sent by the railway on November 11, 1830; as the railways extended the Post Office authorities lost no time in availing themselves of the means which railways offer for expediting the transmission of letters.

Before the morning mails were established a letter from Brighton for a town in Yorkshire was stopped fourteen hours in London, as it could not have been transmitted until eight o'clock at night; but it now reaches its destination (200 miles, say, from London) several hours before it would

formerly have left the Post Office; again, the Liverpool merchant receives his foreign letters on the same day that they reach London, instead of thirty hours afterward.

The traveling or railway post-office, invented by Earle, has been adopted by every important country in the world.

As to the special character of the modern postal system with reference to the saving of time, it is now possible to post a letter in a letter-box in all mail trains, to have it sorted in the train and delivered at its respective town while the train is in motion. The postman has merely to re-sort it at its proper street and slip it in the letter-box of its destined recipient.

Railways carrying the mails are obliged to observe the greatest punctuality. Very heavy fines are imposed upon them if they are late; and it is the same with the mail-boats. Government stipulates that the duration of the Channel voyage shall not exceed two hours and five minutes between the Admiralty Pier at Dover and the Jetty at Calais. But inasmuch as this journey is frequently done under an hour, it will be seen that considerable margin is allowed for these days of speed.

The Post Office department of the United States is responsible for much of the quickening of the railway trains, which during the last ten years or so has become a prominent feature of American railways. The mail contract is given to the railway which undertakes to convey the letters between given points in the quickest time. Such lucrative traffic naturally causes the competing lines to accelerate their service.

CHAPTER VIII

THE BICYCLE—MOTOR CYCLES

WHEN we consider that it is possible for a human animal to propel himself on a pair of wheels without the aid of steam, electricity, or any other agent but his own muscular power, along the earth's surface at the rate of forty-one miles an hour, it is clear that in the bicycle mankind possesses extraordinary means of rapid transit.

Such a means in the eighteenth century and the first thirty years of the nineteenth would of itself have revolutionized the mails and despatch carrying system; but its invention, or rather development, being reserved until the era of railways, of telegraphs, and even of telephones, the economic value of the bicycle has been greatly lessened. Yet it is not a mere instrument of sport and exercise; although even in that character the benefit it confers upon mankind is enormous; it is everywhere, in nearly all civilized countries, an important convenience, offering facilities for transit far superior to the horse, and hardly inferior to the road motor, besides doing without the latter's cost, complexity and disadvantages.

The modern cycle is the lineal descendant of the "dandy" or "hobby-horse" of the early years of the nineteenth century, which is to be found caricatured in countless prints of that epoch. It was a bicycle with wheels attached to a bar of wood rudely shaped like the body of a horse, the

rider sitting astride it and propelling it with his feet upon the ground. In 1819 the Baron Drais de Saverbrunn constructed an improved hobby-horse, and this was introduced into England under the name of the "*célérifère*." It consisted of two stout equal-sized wooden wheels held in iron forks, the rear fork being securely bolted to a bar of wood, the "perch"; the front fork passed

The "Dandy-horse."

through the perch, and was so arranged that it could be turned by a handle, thereby steering the machine after the manner of a modern bicycle. In the middle of the perch was placed a cushion on which the rider sat; in front of this was another and smaller cushion elevated on a bracket,

upon which he leaned his chest. When the rider was seated astride the "*célérifère*" his feet just touched the ground; the machine was propelled by running with long strides, which furnished the momentum during which the rider rested from his efforts. Down hill he could, of course, and did, proceed at a breakneck pace. None of these early "dandy-horses" were fitted with any sort of brake, they were heavily built, and must have rushed down an incline at a startling and dangerous speed. Yet, dangerous and ungraceful as the pastime was, it attained great popularity; no young beau's equipment was considered complete without a hobby-horse; and although they were publicly ridiculed, hobby-riding lasted for several memorable seasons until, indeed, several accidents damped general enthusiasm for the sport. One wit described its votaries as gentlemen who rode in their own carriages and walked in the mud at the same time. In one caricature, the blacksmiths of a posting village are seen chasing the hobby-riders, upsetting them and smashing their machines to fragments with hammers, because, forsooth, the hobby-horse, whose use threatened to become general, never required to be shod.

In 1824 there appeared the following advertisement in the *Mechanic's Magazine*:—

"Self-moving Carriage.

"Mr. D. M'Donald, of Sunderland, informs us that he has invented a self-moving machine for traveling on roads, which has carried seven persons. It is propelled by means of treadles. A man sits behind working the same, and there is a

fly-wheel operating upon two cog-wheels which operate on a square axle. You will perhaps think the man behind has hard labor—not so. From the velocity of the fly-wheel, together with the aid of a lever, which is in the hand of a person in front steering, he has not often to put his feet to the treadles. Mr. M'Donald intends, when he shall have improved the friction of the body of the carriage, to present the same to the Society of Arts; and as he desires to receive no emolument for the same, he hopes it will come into general use."

In the same year there is recorded another example of these so-called "self-moving carriages" invented by a carpenter of Buckland, and another, a Welshman, describes a lever-action machine, which accommodated three persons, and "went with ease eight miles an hour." All of these self-moving carriages were to be propelled by levers. "Velocipedes," or "carriages to go without horses," "manivelociters," "bivectors," "trivectors," "accelerators," "allepodes" are among the names of machines brought forth in the course of the next forty years.

Yet, although the hobby-horse gradually disappeared from fashionable circles, it had shown that even along an ordinary road it could go faster than a man could run, and for a much longer period. In 1830 we learn that certain "improved dandy-horses were supplied to the postmen in a rural district, where they were used for many years." But not being replaced when they wore out (except by the railway), the postmen had once again to trudge on foot.

Ten years later, Kirkpatrick M'Millan, a Scotchman, made a wooden bicycle with cranks, side levers, connecting rods, and pedals. It was used with considerable success for years, and to its inventor, therefore, would seem to belong the honor of making the first bicycle with cranks. Previously, M'Millan had tried his cranks and side levers on a tricycle in 1835. After him came Gavin Dalzell, a Lanarkshire cooper, with a crank-driven bicycle; and in 1862, Messrs. Mayhew, of Chelsea, exhibited a three-wheel velocipede, the front wheel steering as in a modern bicycle or the old hobby-horse, the other two smaller wheels being placed together behind. A pair of cranks was fitted to the front wheel, and on this velocipede it was possible to attain a speed of over ten miles an hour on a smooth track. Four years later, the firm of Michaux, in Paris, sent over to England a perfected bicycle, which, in spite of its weight and clumsiness as compared with the modern machine, seemed then a miracle of grace and lightness. Several of these machines found their way to the London gymnasiums, and became a popular form of sport on a smooth track. One of the earliest long journeys taken in England was by Mr. Mayall, the photographer, who mastered the machine sufficiently to ride from London to Redhill, in an attempt to reach Brighton; "he returned from Redhill by train, exhausted, and covered with dust and glory." It was only a few months before that Mayall had seen his first bicycle at Spencer's gymnasium. "The gymnasium was cleared," he writes, "Mr. Turner took off his coat, grasped the handles of the machine, and with a short run,

and to my intense surprise, vaulted on to it, and putting his feet on the treadles, made the circuit of the room. We were some half-dozen spectators, and I shall never forget our astonishment at the sight of Mr. Turner whirling himself round the room, sitting on a bar above a pair of wheels in a line that ought, as we innocently supposed, to fall down immediately he jumped off the ground."

It must be remembered that up to that period the possibility of remaining upright on two wheels, arranged bicycle-wise, was not generally admitted.

In a short time, certain English manufacturers began to perceive that this so-called toy had a future: the French machines ceased to be imported, owing to the improvements which were made, and soon the manufacture of bicycles was proceeding on a large scale at Coventry. The changes in structure introduced greater lightness and consequently greater speed: the sport took hold of the public, and bicycles were encountered on every leading road. Those who believed in its ephemeral character, and predicted its early relegation to obscurity, were destined to see the error of their ways. It was found that the new machine could carry a man forty, or fifty, and even sixty miles a day, with less exertion than he could walk half the distance. In 1869 Mayall started for Brighton at 8 A.M. and arrived at the Old Ship at tea-time. The head-porter, who had never seen a bicycle, was puzzled about the train the new arrival had come by. He was told that no train had brought him.

"Did you drive or ride a horse? Did you

walk?" were next asked. "No," was the reply, "I came down on those two wheels yonder in the corner: and if you live long enough you will see thousands of others which will carry travelers to Brighton in half the time it took me to come."

In 1894 Mr. Wridgway traveled to Brighton from London and back again in just a little more than five and a half hours.

In June, 1873, it was decided to test the new machine by a ride from London to John o' Groat's, the most northerly point of the kingdom. Four tourists, Messrs. Spencer, Hunt, Leaver, and Wood, took part in this long-distance ride, on machines which, although of the most improved type in 1873, have little resemblance to the Coventry productions of to-day. The four were escorted for a few miles of their way by friends, but soon distanced their escorts, and that evening the message came to London that they had reached Buckden, sixty-five miles away. On the second day they reached Newark, thus achieving forty-three miles. On the ninth day they gained Edinburgh, and the fifteenth day saw the party safely landed at John o' Groat's, 861 miles. This was the first long-distance ride on record, and attracted a great deal of attention; for it brought home forcibly that a new factor of speed had been introduced, which, although inferior to the railway, yet was inferior to it alone. How amazed even the riders would have been to know that twenty-one years later the distance between London and Edinburgh would have been covered on a bicycle in twenty-eight hours.

Yet it was not long after their exploit that H. S. Tharp rode from London to York in

twenty-two and a half hours. In 1876 Smythe and Caston rode 205 miles in twenty-two hours, the actual time in the saddle being seventeen hours seventeen minutes. *Apropos* of Tharp's performance we may compare it with the advertised journey of the regular stage-coach two centuries ago:

"York Four Days Coach Begins The 18th April, 1703. All that are desirous to pass from London to York, or from York to London, or any other place on that road, let them repair to the Black Swan in Holbourne, in London, and to the Black Swan in Coney Street, York, at each of which places they may be received in a stage-coach every Monday, Wednesday and Friday, which performs the whole journey in four days, if God permits." A copy of the foregoing is still preserved at the Black Swan, York.

But the innovation was not to come into general use, for the purpose of rapid transit, without opposition. The medical faculty decried it as injurious to the health, and the coachmen and hackney cabmen followed the example of the blacksmiths of 1819 toward the hobby-horse. In August, 1876, for instance, the driver of the St. Albans' coach lashed with his whip a bicyclist who was passing, while the guard, who had provided himself beforehand with an iron ball on the end of a rope, threw it between the spokes of the machine and dragged it and the rider to the ground. For this assault the driver was fined £2, the guard £5, and a further penalty imposed of £10 for the damage of the machine.

But cycling was not to be dammed by the prejudice of ill-natured or ignorant persons, con-

tests in speed became the order of the day. In 1876, John Keen, who announced himself as the professional bicycle champion, rode fifty miles in three hours six minutes forty-five seconds, and in the following year W. Tomes, of Portsmouth, succeeded in traveling a mile in three minutes ten seconds.

As an illustration of the fact that the future of cycling was not to be limited to sport alone, the Bishop of Manchester publicly stated that a brother bishop had suggested the use of the bicycle in his diocese. So slow was the conference (and, indeed, the public generally) to appreciate the value of the cycle, that this statement was received with roars of laughter. The Bishop of Carlisle facetiously regretted the hilliness of his diocese, remarking that "if there was one thing a bicycle objected to, it was going up hill." The practical use which would be made of the cycle by hundreds, even thousands, of the clergy throughout the length and breadth of the land, they could not yet foresee. Yet, in this year (1878), the *Times* had this to say on the new vehicle:—

"The bicycle has come to the front and is fighting for existence. Dimly prefigured in the mythical centaur, and then in the hobby-horse of mediæval games, and attempted in the velocipede, now half a century old; long prejudiced by the evident superiority of wings to wheels, the bicycle has now surmounted the difficulties of construction, and adapted itself to human capabilities—it augments at least three-fold the locomotive powers of an ordinary man. A bicyclist can perform a journey of a hundred miles in one

day with less fatigue than he could walk thirty; fifty miles—that is, from London to Brighton—as easily as he could walk ten; and a daily journey to and fro between London and the distant suburbs with just the usual results of moderate exercise."

In August, 1879, H. Blackwell, jun., traveled on the "steel steed" from London to John o' Groat's in eleven days four hours, while at Stamford Bridge, on a prepared track, a mile was run by Keen in two minutes fifty-two and one-fifth seconds.

When, in 1880, it was decided by the municipal authorities of Coventry to mount its police officers upon the new machine, the circumstance created wide-spread interest. One commentator, however, suggested that a defaulting debtor pursued by a constable mounted on a tricycle and armed with a summons, sounds more like a horrible dream than a probable reality, and quoted Tennyson's

> "New men, who in the flying of a wheel
> Cry down the past,"

as suitable to the innovation. It may be mentioned that the tricycle dated from 1878, and was the invention of James Starley of Coventry.

It was soon found posible to make great speed on the tricycle, and five years after its introduction C. H. R. Gosset covered over 200 miles in the course of twenty-four hours on the road. At this time, of course, it must be borne in mind that the ordinary bicycle consisted of one great wheel five feet in height, and a smaller one be-

hind, only eighteen inches in diameter. The "safety" bicycle, as it was called, did not become general until 1890, and the "ordinary" held its own, until the advent of the inflated tire made the new machine superior both from the point of view of speed and comfort.

What was regarded as an astonishing feat occurred in 1886, when G. P. Mills traveled on a bicycle from Land's End to John o' Groat's, a distance of 861 miles, in five days one hour forty-five minutes. Some weeks later the same cyclist rode a tricycle over the same course in five days ten hours, or thirty hours faster than it had ever been done before.

As time went on, great and still greater speed came to be attained on the cycle—speed which would have caused the early champions of the "silent steed" to gasp in astonishment. In 1890, in a race viewed by the Prince of Wales, F. J. Osmond accomplished a mile in one minute fifty-five seconds on an old-fashioned high bicycle. But the limit of speed on this form of machine had now been reached: the "safety" and the inflated tire rendered new records possible, and the "ordinary" was soon afterward completely superseded.

Although the cyclists had already surpassed the speed attained by the fast coaches in the halcyon days of coaching, yet the coaching revival was to witness several new records, the most celebrated being the performance of July, 1888, between London and Brighton. In that month, James Selby drove the Brighton coach from the "White Horse Cellars," Piccadilly, *via* Croydon, Merstham, Red Hill, Horley, Crawley,

Hand Cross, Cuckfield, and Clayton to Brighton and back, a distance of 108 miles, in seven hours fifty minutes. This remarkable feat was done with sixteen changes of horses.

It was taken as a challenge by the cyclists, who at once attempted to beat it. At first they met with ill success, but at last the journey was done in eight hours thirty-six minutes nineteen and two-fifth seconds, by four riders using the same machine and dividing the journey into four stages. This, however, was not considered satisfactory. P. C. Wilson and M. A. Holbein made an attempt, single handed, but failed, and it was not until 1890 on an inflated-tire "safety" cycle, that F. Shorland effected the journey in seven hours nineteen minutes. This achievement created great enthusiasm, and was commonly regarded as an unbreakable record. Yet it was not long before S. F. Edge, not only for the first time beat the coach time for the outward journey (three hours eighteen minutes twenty-five seconds), but did the whole in seven hours two minutes fifty seconds.

This was the fastest time ever achieved on a public turnpike by any vehicle whatsoever in Great Britain, and therefore probably in the world. Yet fast as it was, it was to be beaten again and again, before the advent of the motor car was to demolish all road records; and in 1894, C. J. Wridgway accomplished the excursion in five hours thirty-five minutes thirty-two seconds. Even a tricycle, ridden by W. R. Toft, achieving it in six hours twenty-one minutes thirty seconds.

As to other examples of the velocity which can be, and has been attained on the road by means

of the cycle, we might mention that the journey from London to York, 197 miles, has been done in eleven hours fifty-one minutes; and London to Edinburgh, 400 miles, in twenty-eight hours twenty-seven minutes; and London to Liverpool in thirteen hours four minutes. One hundred miles have been covered in four hours thirty-nine minutes twenty-eight seconds, and half that distance in two hours seven minutes and fifteen seconds. Great as these instances are, they are surpassed by the speed of the cycle on a prepared track, where 100 miles have been done in two hours thirty-three minutes forty seconds; and fifty miles in one hour fourteen minutes fifty-five seconds.

The introduction of the motor cycle, driven by steam or electricity, has naturally influenced long-distance records.

Early in the development of the Daimler motor certain French firms turned their attention to it in very small sizes for propelling tricycles. In 1896 a Dion tricycle ran in the Paris-Marseilles race, making an average speed over the whole distance of 14.8 miles an hour. In 1899 a motor tricycle accomplished 28.1 miles an hour, being fitted with a 1¾ h.-p. motor, or twice the power of the first mentioned. A year or two later these tricycles were fitted with 2.25 h.-p. motors, and some with two-speed gear. They soon became exceedingly popular machines, many persons accomplishing long journeys regularly upon them. In the Paris-Malo race of 1899, 231 miles were covered in seven hours eleven minutes, an average of 32.2 miles per hour.

We have already seen that a motor bicycle had

been made by Daimler as far back as 1885, but for the next ten years only spasmodic efforts at improvement occurred. They offered, of course, the several advantages of the ordinary bicycle over the ordinary tricycle, of lightness, easy steering, single or narrow wheel track of smaller dimensions.

In 1895 Wolfmuller invented his petrol motor bicycle.

The cycle, as a useful means of transit, is in universal employment by doctors, clergymen, and dwellers in the suburbs. In certain cities it takes the place of the cab, tram-car, and omnibus, by clerks and business men and women. In the country it is a favorite method of progression. The tradesmen's emissary adopts it in lieu of the horse and cart for the delivery of parcels, and it is in common use by rural postmen. On the whole, the cycle as a means of rapid transit deserves a prominent place in contemporary economy, quite apart from the facilities it offers for exercise and sport, in which, of course, in the mere matter of velocity, it is rivaled by the ice-skate and the toboggan.

CHAPTER IX

MOTOR CARRIAGES

We have already seen in an earlier chapter how the necessity for the speedy conveyance of passengers and merchandise came to be widely felt in England early in the last century. If railways had not appeared upon the scene—the develop-

ment of a new agent of speed would have been inevitable, and that agent would have been the motor car. Railway traveling for the past seventy years has been at best a compromise. The ideal is, of course, a conveyance capable of traveling easily and swiftly to any destination, and not restricted to lengths of rail fixed along a certain route. Railways promptly checked the development of the steam locomotive for the common roads. It was found unnecessary to strive toward the production of a light, speedy vehicle, when a heavy one on an iron track would do as well. Thus, all the early locomotives were what we now designate as motor cars: and are by no means of recent introduction.

Du Halde relates that about the year 1700 the Jesuit missionaries in China invented certain mechanical curiosities for the entertainment of the Emperor Kang-hi. They caused a wagon to be made of light wood, about two feet long, in the middle whereof they placed a brazen vessel full of live coals, and upon them an eolipile, the wind of which issued through a little pipe upon a sort of wheel made like the sail of a windmill. The little wheel turned another with an axle-tree, and by that means the wagon was set a-running for two hours together. The same contrivance was likewise applied to a little ship with four wheels; the eolipile was hidden in the middle of the ship, and the wind issuing out of the two small pipes filled the little sails and made them turn round a long time.

It is a matter of conjecture whether this denotes a kind of steam or hot-air engine. It is, however, significant, that not many years after-

ward Cugnot produced a steam-carriage in Paris, which after having been proved inefficient, was abandoned, and is still to be seen in the Conservatoire des Arts and Métiers. In 1772 an American, Oliver Evans, began experiments with steam with a view to employing it as a substitute for animal power. Evans was sanguine enough to declare that steam would one day be the prime agent of locomotion; and frequently predicted that the time would come when travelers would be conveyed on good turnpike roads at fifteen miles an hour or 300 miles a day by a device resembling his own. During the next thirty years innumerable were the attempts of English inventors to employ steam-power on common roads. The outlook appeared encouraging; for once they had succeeded with their engine, they need not trouble about railways; excellent highways already existed along which to conduct traffic. In the part of this book relating to railways, mention has already been made of the Cornishman Trevethick's experiments. Griffiths introduced a steam-carriage in 1821; another by Gordon in the following year was contrived to work inside a large iron drum, as a squirrel runs in his revolving cage, but was quickly abandoned. Gurney next produced his engine, which was marked by clever construction, the objectionable noise being overcome by causing the waste steam to enter a chamber from which it issued with a steady and noiseless current to the funnel. In 1826 it performed the journey from London to Bath, at which time other competitors were in the field. Dance, Maceroni, Church, and Hancock each produced a road locomotive. In 1831 Gur-

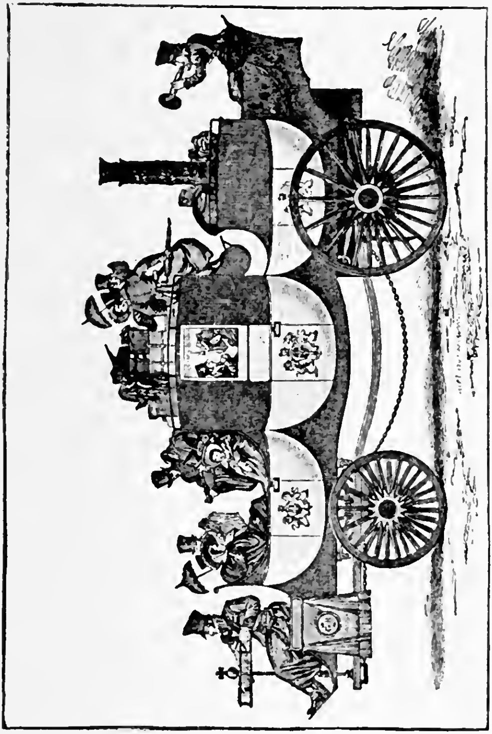
ney had three steam-carriages running for the conveyance of passengers on the road between Cheltenham and Gloucester, four trips being made daily, at a greater rate of speed than that of the stage-coaches on the same nine miles of road and at half their fares.

This success betokened the permanency of the new enterprise, but prejudice was strong; a formidable opposition was organized, injurious reports were circulated and all travelers cautioned against trusting themselves to the dangers of steam. A more effectual hindrance was offered by the parochial authorities, who covered a portion of the road to a depth of eighteen inches with loose stones. While attempting to surmount this impediment the working axle of the engine was broken and a stop thereby put to steam locomotion in this quarter, for a time. Ere the inventor could renew it, local opposition had crushed the whole enterprise.

While this was happening to automobiles at Cheltenham, Hancock started a steam-carriage —the *Infant*—to run between Stratford and London. It excited much attention owing to the compactness and efficiency of its arrangements, and led to attempts in other quarters. It was even proposed by the more sanguine projectors to run steam omnibuses in all the great thoroughfares of London — a consummation which three-quarters of a century has not sufficed to bring about—as well as in the suburban districts and coaches for Birmingham and Bristol.

Hancock built nine carriages altogether, the first being the *Infant* and the *Era*, built in 1831-2. The latter was intended to run the coach between

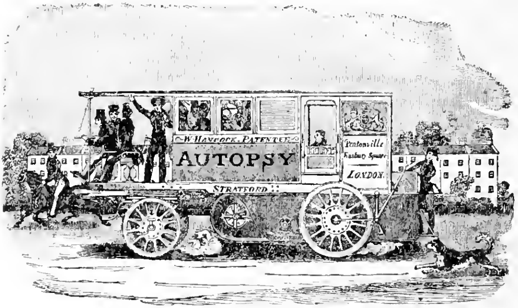
London and Greenwich, but the company for which it was built never got into working order. Another, however, the London and Paddington



James's Steam-carriage.

Steam Carriage Company, was started in 1832, and Hancock's next carriage was built to its order. The fourth, he ran daily for twenty-four

weeks between Finsbury Square and Pentonville. But although thousands of passengers were carried by these vehicles, yet commercial success was not very promising for town service at the time, and extended practise and experience were required to make what, even with good roads, would have proved attractive and successful vehicles. Frequent mishaps occurred, and it is



Steam Road Coach, 1833.

to be feared that the comfort of the vehicles was not even up to the standard of the time. The passengers were all in front of the machinery, but with powerful and unbalanced engines, and with the rough chain-gear, the vibration was considerable. One, for example, had cylinders no less than nine inches in diameter, and these engines had no fly-wheels. Yet, after all, these things were matters for improvement, which would have naturally followed demand for the coaches, and for improved tools and methods of building.

When Summers and Ogle were examined be-

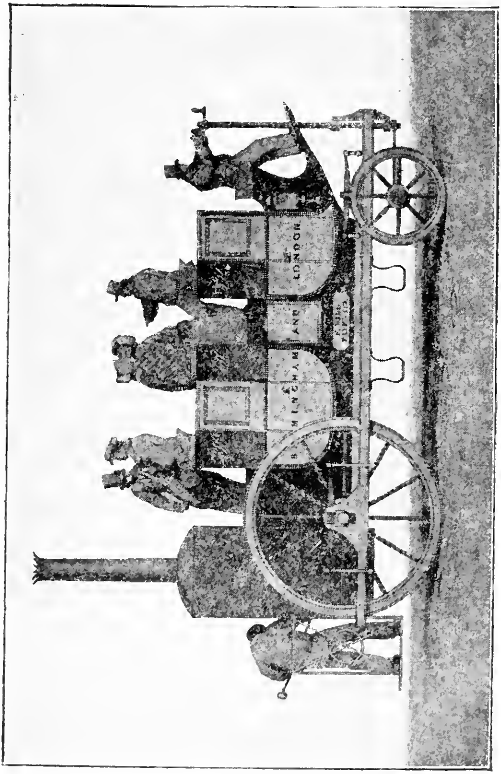
fore the Select Committee of the House of Commons in 1831, they stated that with one of the two steam-carriages of their construction, they had frequently made thirty miles an hour. It was certainly a daring thing these men did in using steam pressures of over 200 lbs. per square inch, in those days of imperfect boilers.

The coaches built by Hill about 1840 would carry nine passengers and a driver, conductor, and stoker, at considerable speed on the precipitous route between London and Hastings. This journey of 128 miles was done in a single day.

But all of these steam coaches and carriages were one after another abandoned, until after the disappearance of Hill's carriage in 1843 not one was left on the road, and none are, so far as is known, preserved. The boorish and unjust treatment meted out to these pioneers effectually put an end to progress in steam road locomotion, so far as Great Britain was concerned, and further harsh and narrow-minded legislation from 1861 to 1878 prevented England from taking advantage of the progress which had been made on the Continent.

Great Britain had for half a century been as near to a practical self-moving carriage as was France when Serpollet, Bollée, Scotte, and De Dion and Bouton began in the early nineties, and before the celebrated invention of Gottlieb Daimler enabled Levassor to build his high-speed internal combustion motor, and Benz had demonstrated its practicability. England also possessed the Daimler motor and was aware of Benz's labors, but it would have been futile to

attempt to make a motor carriage when Englishmen were without the freedom to use their own roads.



F. Hill's Steam-carriage, Running Between London and Birmingham, 1839–1843.

The common roads were consecrated to the uses of horses, latterly of cyclists; to use a mechanically propelled vehicle upon them was

considered an outrage. The opponents, therefore, of rapid transit upon the common roads retarded progress and experiment for full sixty years.

Nevertheless, although British inventors were denied facilities for progress in their country, the British public was very quick to reap the benefits slowly derived through foreign genius and industry. France lent free roads to Bollée, Serpollet, Le Blant, and others turned out a succession of ingenious steam vehicles, but it was not until the advent of the Daimler motor and the Benz motor cars that any real, rapid, and continuous progress was made.

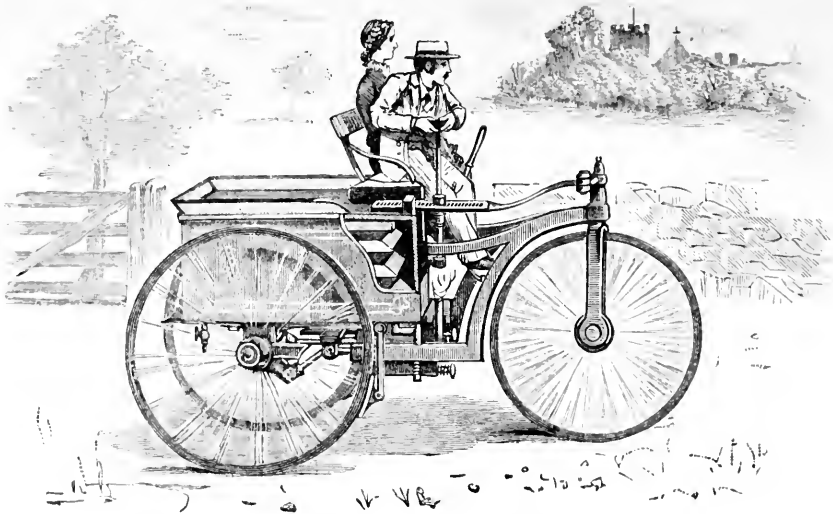
We have now witnessed the successful employment of steam for traction, and while the world is anxiously waiting for the development of electricity, a new agent appears. Experiments had long been made with gas and hot air as the motive power of engines: science was now ready to experiment with oil and carburetted air. It was known that the lighter oils, such as petroleum spirit (petrol), or gasoline, or benzoline will all evaporate readily in presence of air and especially in air in motion. When the air is saturated with the oil, *i.e.*, contains 17.5 per cent., it will burn, giving a fine white light. Such a mixture of oil, vapor, and air will also burn with explosive rapidity under the circumstances of its combustion in a gas or oil cylinder.

Gottlieb Daimler, who had been for some years occupied in gas-engine construction, turned his attention to the production of small light petrol motors, made highly powerful by their capability of running continuously at very high speeds of

rotation. In 1884 he patented his first high-speed gas-engine, and in the following year applied his improved invention to a bicycle. This machine was rather clumsy in appearance, but it excited then, and does yet, the deepest interest. For it, Daimler devised the first of the carburettors, of which there are now so many for carburetting air with mineral and other spirit for motor purposes. The cylinder was cooled by an enclosed fan wheel which sent air round the cylinders within a jacket.

Daimler's new engines, many of which were made for launches or fixed engine purposes, finally led to what became celebrated as the Daimler motor, which was introduced into England about 1892. It did not, however, obtain universal recognition until the successes of the Panhard and Levassor and the Peugeot carriages (known as Daimler carriages as distinct from steam-carriages) appeared between 1894 and 1896. A description of the principles and mechanism of the Daimler motor will enable the reader to understand the idea of motors generally, as applied to motor bicycles, tricycles, and carriages, which have introduced such a powerful element of speed into the common road traffic of the world.

To begin with then, all these modern gas and oil engines are really hot-air engines, *i.e.*, in which the expansion in volume of air when heated is employed to give rise to pressure on a moving piston, that expansion being effected in the cylinder containing that piston by the explosive or rapid combustion of a small charge of combustible, such as ordinary coal gas or the



An Early Gas-propelled Vehicle.

vapor from naphtha, or petroleum spirit, or from petroleum when vaporized under higher temperature in presence of air. This heating, expansion, and cooling of the air is all done therefore in the working cylinder. In the earlier hot-air engines of Stirling and Ericsson, on the other hand, two pistons were used, one acting merely as a displacer piston for passing cooled air, which had done work in a working cylinder, back into a working chamber, where it was heated, and being again heated escaped to the working piston which was in a position to be pushed out, while the displacer piston was almost still. Such were of necessity slow speed engines, large for their power, and very wasteful as heat engines in spite of certain theories.

The modern light, spirit, or gas engine has a single piston, which in its descent draws air into the upper part of the cylinder. The rushing current of air creates a partial vacuum in one of the tubes, the lower end of which dips into the petroleum.

By this means a small quantity of oil is drawn up scent-spray fashion, and rushes with the air into the cylinder. The latter, then, is now full of air, with which is mixed the "petrol" vapor, or, in other words, carburetted air. The return or rising stroke of the piston taking place, the carburetted air is forced into the top of the cylinder at a pressure of about 45 lbs. per square inch. When the piston has reached its topmost position in the cylinder, the temperature of the air and vapor mixture being raised by its compression, it is readily ignited by the incandescent walls of the "ignition tube." This being effected

just as the piston is ready to begin its down stroke, the temperature of the air (about 1800° F.) naturally enhances its volume twenty-fold; there is no escape but by the downward movement of the piston. When the piston reaches the end of its downward stroke, an exhaust valve is lifted, and the products of combustion of the vapor and air forming the last working charge escape into a subjacent passage; the oil supply is brought by a pipe situated in some convenient part of the carriage. A point to be remembered is that the engine makes four strokes, or two revolutions, at least, for one working stroke, a cycle or series of operations first used in the Otto gas engines. The very high temperature, due to the combustion of the charge in the cylinder, would heat the latter also to a very high temperature, were it not that ingenious means are adopted for keeping it sufficiently cool. This consists of a slow current of water passing round the cylinder in a "water jacket," the casting containing the valves being similarly protected. As a considerable quantity of water would otherwise have to be carried for cooling purposes, several kinds of water coolers have been invented to meet this difficulty.

It is clear, therefore, that, with the exception of the means and apparatus for converting the petrol into vapor, the Daimler motor is really a gas engine. In the Benz and De Dion engines this characteristic is even more apparent, for in these instead of a spray-making carburettor, as above described, a supply of strongly carburetted air is provided by a petrol surface evaporator, which the engine receives just as a gas engine

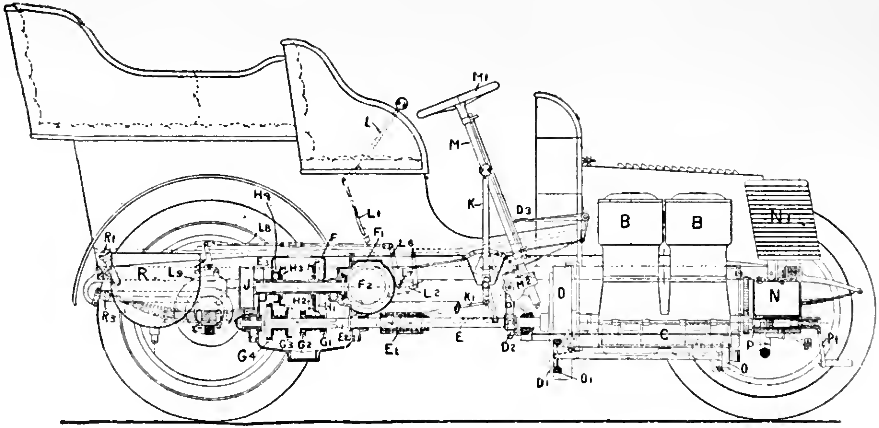
receives gas and mixes it with air sufficient for combustion, more or less, according to requirements.

Carl Benz of Mannheim in 1886 took out a patent for an oil-spirit motor tricycle, the forerunner of the Benz car now so widely known. In this car the piston in the cylinder was connected to a vertical crank-shaft. In the second car made by Benz he ran at about ten miles an hour, while two years later, in 1888, he secured a speed of from twelve to fifteen miles an hour. The inventor seems to have given his cars more liberal size of engine for such small vehicles than many succeeding makers in their first efforts.

There is no governor on the Benz motor, speed being controlled by the point or period of ignition of the oil vapor, as already described, and by means of a throttle valve. Thus the driver may vary the speed of the motor by varying the quantity of the mixture from about 250 to 900 revolutions per minute without leaving his seat. The maximum of the Benz motor car in the Berlin-Leipzig race in September, 1899, was thirty-seven miles an hour.

About the same time several English inventors had patented petroleum motors, notably Butler & Roots, but it was not until MM. Panhard & Levassor, of Paris, acquired the Daimler motor rights, and began to exploit it in the manufacture of carriages, that the new automobile became popular.

Up to that time, the future of self-propelled carriages seemed to be solely either with steam or electricity. In 1880 the elder Bollée of Mans constructed a steam coach, which went at the



A Modern Motor Car.
(See Frontispiece.)

rate of ten miles an hour, and numerous automobiles were built during that decade. In 1889 Leon Serpollet invented and made the instantaneous generator or boiler now widely known by his name. As at first constructed, this generator was composed of a large number of flat tubes, with only a capillary water space. The tubes were surrounded by a coating of cast-iron, which rendered them very heavy, but protected the steel tube from rapid corrosion in the high heat of the furnace in and above which they were placed. It also acted as a heat accumulator during the time when the engines were stopped, and no water was being pumped through for evaporation. The boiler gave very high pressure steam considerably superheated. Various modifications of form subsequently took place, and in 1895 one of Serpollet's carriages was sent to England and tested, the trials exciting considerable scientific interest. But by that time as many as ninety oil or gas driven machines on the Daimler principle had been turned out in Paris, and in order to test respective merits of the two species of automobile, a race was organized between Paris and Rouen, 79.4 miles. The race was won by a De Dion & Bouton steam tractor, to which was attached an ordinary landau. It made an average speed of twelve miles an hour and was shown at the first exhibition of motor cars in England, that organized by Sir David Salomons in October, 1894.

But the superiority of steam was not to be long maintained. Another race between Paris and Bordeaux, 735 miles, occurred in June, 1895,

when M. Levassor drove one of his automobiles over the route in forty-eight hours forty-eight minutes, at a mean speed of about fifteen miles an hour on the whole run, with a maximum speed of eighteen miles. The carriage weighed about twelve hundredweight, and won the race, a Peugeot car, also equipped with a Daimler motor, coming second.

From that race to the present time, the triumph of the mineral-spirit motor has been marked.

In 1896, in the race from Paris to Marseilles, a distance of 1,060 miles, no fewer than thirty-two vehicles started, a Panhard motor covering the distance in sixty-seven hours forty-three minutes, or an average speed of 15.62 miles per hour over the whole of that long run. There were three steam cars among the competitors, but all failed from one cause or another; one, however, only owing to the break-down of its pneumatic tires, for which it was too heavy.

Nevertheless, a De Dion steam brake run by the Marquis de Chasseloup-Loubat won the Marseilles-Nice race in January, 1897, achieving the journey of 144½ miles in seven hours forty-five minutes, or eighteen miles an hour. When fully loaded this brake, with passengers, weighed nearly three tons, but on this run it reached higher speeds than had previously been made, thirty-six miles an hour being attained for short distances.

The records of speed in motor cars quickly began to be lowered. In the Paris-Dieppe race in 1897, a mean speed of twenty-five miles an hour was reached, which placed the automobile

on a par with the bicycle in the matter of speed over common roads. The Paris-Amsterdam race in 1898 showed 27.7 miles an hour; in 1899 the Versailles-Bordeaux race, 344 miles without a single stop, at an average of 30.2 miles for the whole journey, occasionally its speed reaching fifty miles an hour. This was accomplished on a Panhard motor car carrying two persons, weighing one ton, and fitted with a twelve- to fifteen-horse motor.

In the United Kingdom, in 1896, after much agitation, the old restrictions were to a large extent removed, and the adoption of the motor and its construction in England instantly followed. The Daimler motor was employed to propel every form of luxuriously fitted carriage, private omnibus, sporting car, light delivery van or lorry.

A glance at the frontispiece and at the diagram on page 175, to which the following key is given, will show the reader the modern petrol car in its most perfect form:

B, B, cylinders; C, crank chamber; E, shaft; F, change-speed gear case; H, transverse casing; G^1, sliding spur wheels—low speed; G^2, sliding spur wheels—intermediate speed; G^3, sliding spur wheels—top speed; H, H^1, H^2, H^3, spur wheels; K, hand lever; K^4, rods; K^2, slotted quadrant; K^3, slot; J, water-jacketed brake drum; J^1, connecting rods; J^2, foot pedal; L, hand lever; L^1, adjustable rod; L^2, bell crank lever; L^3, parallel lever; L^4, pivot; L^5, horizontal lever; L^6, ends of levers; L^7, pivots; L^8, operating rods; L^9, side brakes; M, inclined pillar of steering gear; M^1, steering wheel; N, water

tank; O, circulating pump; P, starting handle; R, petrol tank; R^2, exhaust box; R^3, escape pipe.

There is certainly one objectionable feature in the type of motors just described—speed is only attained by a change of gear in transit: that is to say, it is necessary to push the teeth of spur wheels into the gear while running in order to change the degree of speed, by affecting the number of revolutions per minute of the motor-shaft. Thus to change from three miles per hour to six miles, a pair of spur wheels had to be thrown out of gear and another pair thrown in by a stroke of the hand, which would raise the speed of the counter-shaft from 220 to 440 revolutions, and so on. Of course a skilful motorist learned to use the clumsy mechanism so adroitly that the occupants of the car hardly became aware that its acceleration in feet per second underwent a change. On the other hand the shocks and strains inflicted upon gear by less experienced drivers often wrought more damage in a minute than good running would do in a year.

As a method of avoiding all these drawbacks, belt gear has been introduced.

In the United States a very light and useful steam-carriage has been produced. They are of simple construction, and carry fifteen gallons of water, which is sufficient for a run of about twenty-five miles. A gallon of petrol is required to heat this quantity; the boilers are of the tubular type.

As to motors driven by electricity, little progress has so far been made, owing to the fact

that the weight of the storage batteries does not permit them to be employed except for short distances.

In 1898-99 a number of electrically driven cabs were tried in London; but the experiment failed, and it was not until 1902 that the announcement of Mr. Edison's improved storage battery opened up new possibilities for the electric motor car.

Very few of the present electrical motors run over forty miles without recharging, and that operation takes several hours. For the new battery, however, is claimed that it can be charged for a twenty-mile run in forty minutes. The proportion of weight to power is said to be 53 lbs. to one horse-power.

The Edison battery does not depreciate, there being no acid to eat away the metal, and it "will wear out several automobiles before succumbing itself." Moreover, "the cost of recharging the batteries will be about the same as gasoline, but there will be a great saving in the cost of maintenance, and also freedom from the annoyance of frequent stoppage of power." The cells are composed of tiny bricks of specially prepared iron and nickel. In charging and discharging oxygen is driven from one metal to the other, and then back again through the action of a potash solution, and without corrosion or waste. Experiments have been made with one consisting of twenty-one cells, weighing altogether 332 lbs., and this propelled a "runabout" car sixty-two miles over roads of varying quality and grade. The run on comparatively level ground with the same battery

was continued for eighty-five miles before the vehicle came to a standstill.

Renewal of the water supply is all that is needed to keep the cells in good condition, and a process of recharging has been improved, so that less time is consumed than for the recharging of other batteries. Electric vehicles for city work, delivery wagons, etc., will soon supersede all other kinds of vehicles, and with a hundred-mile battery a vehicle should have little trouble in making a run almost over the whole country. Mr. Edison believes that the application of storage batteries will ultimately be extended to trains and ships, and if all be true that is claimed for the invention, it will certainly prove a boon to motorists, and will provide a means of propulsion for airships that will make such a catastrophe as that which overtook the airship *Pax* an impossibility.

The motor car is already largely influencing our social life. It has greatly extended the radius of action of every one who can afford to keep a carriage, because by its use Brighton is brought within a day's drive from London, and Bath is within the limits of a week-end excursion by road. It will largely affect the surburban traffic of our railways, and improve the delivery of goods and parcels in the country. It has already begun to be used by the Post Office, and will soon be generally adopted. The roads of Europe promise to be as busy again, if not busier than in the old posting days, and, as one writer remarks, "instead of post horses the cry will be for petrol."

CHAPTER X

STREET RAILWAYS

Rapid transit between the business quarters of great cities and their suburbs is entirely a modern problem, and mostly a very recent one. The brilliant achievements of street railway engineers in the present generation have only kept pace with urgent necessities. The growth of many great cities in Great Britain and the United States has been wonderful, and has been maintained at a constant rate. Such a growth means increase in the peopled area of each city, and thus the distances to be traversed from the residential suburbs to the business district are perpetually increasing.

As it is in cities that the multiplicity of traffic occasions the most inconvenience, it is also where the need for the rapid transit of goods and passengers is most marked.

Yet so effectually had public enterprise and capital in Great Britain centred in the steam locomotive and the railroads in connection therewith, that for thirty or forty years following urban transportation was sadly neglected, and, particularly in London, facilities for rapid movement left much to seek. Prior to the construction of the Underground Railway, rapid transit in London was represented by the omnibus, first started July, 1829, and the hackney coach or cab.

But in the interval the Americans had long

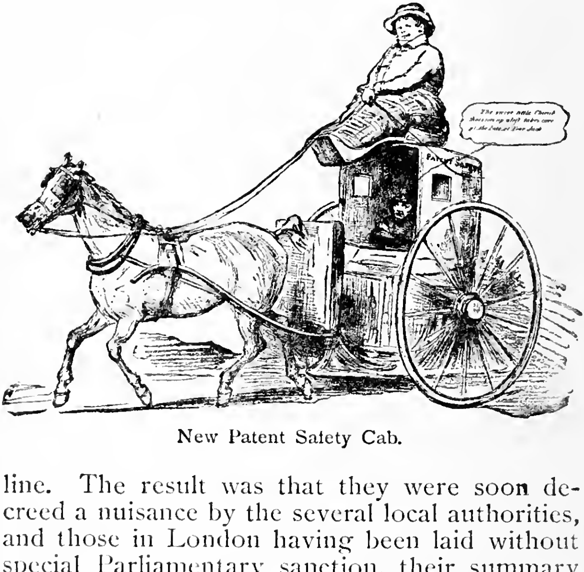
perceived the merits of the street railway system in accelerating the movements of the urban population. In New York, the Fourth Avenue (Harlem) Street Railway was chartered in 1831, and for twenty years maintained a monopoly of the street railway traffic, after which a general ex-

The First Omnibus.

tension of the system followed in the large cities. Philadelphia and Boston opened street railways in 1857, and from that period to the present the growth of street railways in America has been so wide-spread that more than 500 towns and cities are equipped with this means of rapid locomotion. As we shall see, although horse traction was in the first instance resorted to,

yet this was, in many instances, succeeded by the cable system, and latterly by electricity.

In 1858-59 an enterprising American, George Francis Train, obtained permission to establish several short street railways in England. But the rails were of a most objectionable and inconvenient form, their projecting flanges making it difficult and even dangerous for ordinary vehicles to cross the line save at right angles to the



New Patent Safety Cab.

line. The result was that they were soon decreed a nuisance by the several local authorities, and those in London having been laid without special Parliamentary sanction, their summary removal was ordered.

But ten years later, an agitation having been vigorously carried on meanwhile, and the Metropolitan toll-bar system abolished, street rail-

ways reappeared in force. Several companies were incorporated for London in 1869-70, and in the course of the next decade the larger provincial towns had followed the example of the capital. At present fully 1,000 miles of street railways are built and in operation in the United Kingdom, with a capital of some fourteen millions sterling, and carrying annually about 600 million passengers.

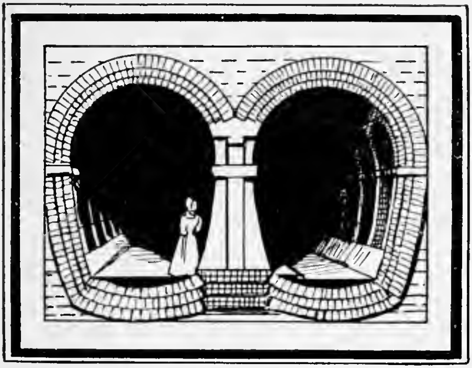
The growing development of street railways, which made it possible for the industrial classes to avail themselves for the first time of the advantages of rapid locomotion, naturally led to still further efforts on the part of the projectors to lessen the cost of working, as well as to increase the speed. Various patents had been taken out for cable traction, *i.e.*, in which a rope should travel enclosed in an underground pipe, with a grip attachment on the cars capable of clutching or releasing the moving cable. The first practical application of this plan was made in San Francisco in 1873 by the building of the Clay Street cable line. The road, which is about a mile long, has, in parts, a gradient of one in six, and rises to a height of 300 feet above its low-level terminus. Animal traction was, of course, impracticable over such a route, and the success of the new cable system being ascertained, it was applied to other lines. San Francisco alone having 100 miles of cable lines in operation. Ten years afterward Chicago built its first cable line, and it was also about the same time adopted for the Brooklyn Bridge Railway, which conveys an average of 35,000 people in the single hour between 5 and 6 P.M. daily. It

was also applied to the great Broadway line, now operated by electricity.

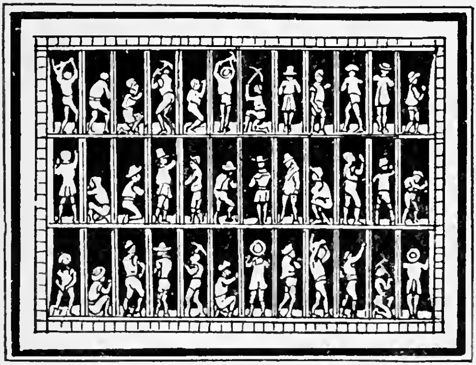
England was somewhat tardy in using cable traction, and, when adopted, it was only on a very limited scale, one great reason being the relative narrowness and crookedness of the streets. The Highgate Hill cable line was opened in 1884, and other lines have been built in Edinburgh, Birmingham, Bristol, and Matlock. The Brixton tramway has superseded horse-power by a cable. Australia and New Zealand have also largely adopted the cable system.

But the greater advantages of electricity were not long in becoming manifest, especially in the United States. In New York, Boston, Chicago, and Philadelphia, and hundreds of smaller cities the electric trolley system has grown almost universal, whereby speed has been doubled, and the heart of the city made accessible at slight cost to the dwellers in the suburbs. After a considerable interval electric street railways secured a footing in Great Britain, such towns as Glasgow, Nottingham, and Norwich preceding the capital, which did not enjoy such a service until 1901, when the Shepherd's Bush and Kew to Southall lines were opened.

There can be no question, however, that no matter how conservative London may have been as regards speed in transit, the establishment of some system partially effecting this for the mass of the population would have previously taken place but for the building of the underground Metropolitan Railway. When the idea was first proposed of a railway for human beings to travel



No. 1. Showing construction.



No. 2. Iron shields, with a workman in each compartment.

THE THAMES TUNNEL.

along under the streets and among the sewers it was regarded with contemptuous amusement. But London's stupendous growth demanded new and improved means of communication; the streets were already too congested with traffic; the choice lay between a railway over the top of the houses or beneath the pavement, and the latter alternative was the one chosen. Of course, the omnibus and cab interests, unconsciously following the example of their predecessors, the stage-coachmen, were fiercely opposed to the scheme, but when powerless to prevent it, wreaked their spleen in bitter jests and sarcasm.

In 1854 the first Act of Parliament was passed authorizing the line, and the works began in 1860. Three years later the first section of the line—Paddington to Farringdon Street—was opened, in which year the Lords' Committee recommended that the inner circle of the further projected lines should abut upon, if not actually join, most of the principal railway termini in the metropolis. The total length of the inner circle is 13 miles 176 yards, two miles of which length is laid with four lines of rails, and the total length of the two underground systems is over forty miles. Even when the utmost precautions are taken, tunneling through a town is a risky operation. Settlements may occur years after the completion of the works; water mains may be broken in the streets and in the houses; stone staircases may fall down; and other unpleasant symptoms of unstability may show themselves. But rapid transit was the goal in view; in the case of London, and, indeed, all large cities, railways designed for local service must of necessity be either

Elevated Railway, New York.

sunk below or raised above the street level; and London public opinion was against the elevated railway, which has had such a great success in New York and Liverpool. By means of the new "Underground" it became possible, no matter how congested the street traffic, to reach the Bank from Hammersmith, a distance of seven miles, traversing or rather following the line of most resistance, in twenty minutes. Here, then, we see a vast improvement as regards economy of time. In 1800 a walk (there was no other popular means of transit) to the Bank from Hammersmith occupied about two hours; in 1850 the omnibus did the journey in fifty minutes.

But New York was soon to be better served than London. In 1867 the first attempt was made to improve existing means of transit between the residential and the business quarters of the city by the construction of an elevated railway actuated by a wire rope and a stationary engine. The undertaking passed into other hands in 1872, and by 1880 the elevated railway system was worked over thirty-four and a half miles of line; 165,000 passengers on an average were carried per day, and trains ran every two minutes during the morning and evening, with a somewhat longer interval in the quieter hours of the day. The railway is supported on square, wrought-iron lattice-work columns let into cast-iron base-blocks, founded on brickwork and concrete, at a distance of from thirty-seven to forty-four feet apart. In parts, where the street traffic is crowded, a single row of columns is planted in the line of each curb, on the upper ends of which a pair of longitudinal

girders are fixed to carry a line of way twenty-two and a half feet high above street level, at each side of the street. In other situations the two lines of way are supported at a height of twenty-one feet on longitudinal girders in the middle of the street fixed to transverse girders which span the street and are carried on columns at the curbs. The system certainly has its drawbacks, and does not make for beauty or picturesqueness, but for a time, even when the locomotives were worked by steam, it made New York the most admirably served city in the world in the matter of rapid transit, it being possible to go from Harlem to the Battery, nine miles, in thirty minutes.

Meanwhile, the world's greatest city had rested content with the facilities afforded by its underground railway and its horse-traction tramways, in spite of the daily increasing evidences that these were inadequate to the needs of the huge metropolis. At length, in 1890, an electric railway, the City and South London, was opened.

The main question at present is to decide upon the respective merits of the polyphase alternating current system and of the standard or direct-current in their application to electric traction. Engineers generally are aware that the change from steam to electricity is bound to come in Great Britain, and are naturally anxious to acquire experience in the working of both systems. The Central London railway is an example of the direct-current system, and apart from the excessive vibration, has so far been successful. It has been shown in Germany that the three-phase or Ganz system is capable, under the present construction, of 125 miles an hour. But this ques-

tion of high speed has little or no bearing on a short line such as the Metropolitan or District railways of London.

In London three tubular electric railways are in operation, nine others are in course of construction or have been authorized, in all fifty-two miles. It is proposed to work the whole of these lines on what is known to electricians as the "multiple-unit" system, and under the supervision of a single authority. If these various deep-tunnel roads adopt one system on all sections, the companies working harmoniously together, London would have the most perfect high-speed transit network in the world. The "multiple-unit" system has already been proved to be the best practically and commercially for urban rapid transit. Its main principle consists in making up every train of a series of perfect and independent units, any one of which can, if required, be operated by itself or detached without interfering with the other units. Each unit may consist of two motor cars, one at each end, and the unit can be worked from either end (only one set of motors working at a time), and can therefore be reversed at any crossing, at the terminus, or in case of breakdown on the line. To the motorman the driving is simplicity itself, for the whole series is, in operation, but a long unit. The direct current conveyed at a low voltage to each motor is automatically limited to its safe capacity. This is the system in use in Chicago; on the Brooklyn and Boston Elevated Railways; on the Paris-Versailles Railway; and on the Berlin Elevated and Underground Electric Railway.

In the United States at present there are no fewer than 150 electric railways more than fifty miles in length, and these, in many cases, run parallel with existing steam lines, competing for the passenger traffic in the most populous districts. The linking of New York and Boston by an electric railroad more than 185 miles long is all but complete. The Jersey City electric system has extended within twenty miles of Philadelphia. The New York Elevated Railway is now equipped with electric motors. The New York Rapid Transit Subway, begun in March, 1900, promises to be one of the greatest in the world, and its construction, much of it under the busiest streets of the great metropolis, has been one of the greatest and most interesting engineering problems of recent years. The route embraces a line extending the entire length of Manhattan Island, from City Hall Park to Kingsbridge; another touching the main line at 104th Street and extending northeastward into the Bronx district as far as Bronx Park; and an extension down Broadway to Battery Park and thence under the East River to Brooklyn, in all about twenty-five miles of track. The cars are to be operated by electricity.

Nevertheless, speed is ~~no~~ 2 times faster on the new electric lines than on those worked by steam. Until the problem of high speed, long distance, electric traction has been satisfactorily solved, the latter are in no immediate danger of displacement. But in the great cities, electric traction is rendering a solution of the housing problem also at hand; it must in time effect a complete redistribution of the population of overcrowded

London. The working man will more and more make his home in the purer air of the suburbs, and the jaded professional man and merchant will live on the coast or in the country, conveyed by high-speed electric trains in the same time that it now takes steam trains to crawl to the suburbs.

Moreover, there is a growing need of a subway for freight trains, so that heavy goods can be taken from ships and ferries, and carried on belt-line cars to warehouses and stores in different parts of the city. At present the transfer of baggage and freight through New York City is very expensive, as well as slow and troublesome. A tunnel freight road would greatly promote the prosperity of the city as well as the convenience of shippers.

In a few years the whole city may be undermined with railroad tunnels and passenger subways between tunnel stations and business blocks. As soon as the people begin to enjoy the improved facilities, the demand for rapid extension will be too strong to resist.

The cities that are foremost in this movement will become the object lessons of the world. Each city has its own peculiar conditions to meet, and yet so many conditions are common to all that in time a kind of standard practise will be evolved through the experience of different communities.

A recent investigation shows that of thirty-seven representative cities in twenty-five different countries all over the world, eight of the municipalities own and operate the street transportation lines; four own the lines and lease them to companies which operate them; and in three others provision is made for municipal

ownership at a future time. In eight of these cities passengers are allowed to stand in the aisles; in all others it is forbidden.

Not only has the number of street accidents per thousand of population been greatly diminished by the modern methods of transit, but as the horses and mules have been duly supplanted, the average health of the community has improved. This is probably one of the many reasons for the reduction of the death-rate in New York City from 26.30 in 1888 to 18.88 in 1899. Thus through the practical science of rapid transit all things work together for human good. Rapid transit is a necessity of modern city life; but in satisfying this necessity a multitude of benefits accrue to the whole community. The result of all this costly effort must influence the future course of civilization and perfect in a decided fashion the modern city which owes its present congestion to the development of steam railroads.

Ian Maclaren recently wrote of Americans: "No man goes slow if he has the chance of going fast; no man stops to talk if he can talk walking; no man walks if he can ride in a trolley-car; no one goes on a trolley-car if he can get in a convenient steam car; and by and by, no one will go in a steam car if he can be shot through a pneumatic tube. . . . There is nothing," he added, "an American cannot do, except rest."

This reference to the pneumatic tube suggests the higher hopes which have from time to time been entertained of this agent as a means of rapid transit.

Early in the last century Medhurst made a proposal to construct a railway on this principle, the carriages moving through an air-tight tunnel. A short pneumatic railway was laid down in the Crystal Palace grounds in 1865 by Mr. Rammel. It consisted of a single line of rails in a tunnel 600 yards in length, along which ran a carriage. Motion to the latter was conveyed by means of a fan or hollow disk twenty-two feet in diameter, which either condensed or rarefied the air as required according to the adjustment of certain valves. This experiment was, however, soon discontinued, and the only way air is used now in the propulsion of vehicles is in a compressed state, and working a compressed-air engine, as at Paris, Nantes, and Chester.

The mono-rail promises to work wonders in the near future. It is now proposed to adopt it between London and Brighton and Manchester and Liverpool, where Behr's system claims to attain the high speed of 110 miles an hour. During trials made in 1898 in Belgium, the highest official recorded speed was 83 miles, the traveling being smooth and pleasant.

The accompanying illustration shows the moving platform in operation, a system from which also much is expected.

When one is asked "What is the value of rapid transit? what difference does it make whether we reach Edinburgh in eight hours or eighteen, or gain Cologne from London in sixteen or thirty hours?" the answer to both is easy. Despatch is not only the soul of business, but international understanding and good-will

largely depend upon facile intercommunication. According to Professor Bryce, in enumerating the causes of Anglo-American amity, "the ocean steamers have done perhaps most of all, because they have enabled the two peoples to know each other." When it was a two days' journey from

Moving Platform, Paris Exhibition, 1900.

London to Calais, a comprehension of France, such as is enjoyed to-day by many thousands, was impossible to Englishmen.

As to the far future of rapid transit only the poet and dreamer can tell us, he who has

> ". . . dipt into the future far as human eye can see,
> Saw the vision of the world and all the wonders that would be.
> Saw the heaven fill with commerce, argosies of magic sails,
> Pilots of the purple twilight, dropping down with costly bales."

In ten years' time (Baron Henri de Roths-

child has prophesied) there will not be a single vehicle in Paris drawn by a horse. The ingenious author of "Anticipations" believes that the motor—hired or privately owned—will solve for first-class passengers the problem of transit in the future. It will be capable of a day's journey of 300 miles or more; one will change nothing—unless it be the driver—from stage to stage, moving as one wishes and resting where one wishes, combining all the attractiveness of old-fashioned posting, with quadruple and quintuple speed.

"No one," says Mr. Wells, "who has studied the civil history of the nineteenth century will deny how far-reaching the consequences of changes in transit may be, and no one who has studied the military performance of General Buller and General De Wet but will see that upon transport, upon locomotion, may also hang the most momentous issues of politics and war. The growth of our great cities, the rapid peopling of America, the entry of China into the field of European politics are, for example, quite obviously and directly consequences of new methods of locomotion."

Decry all speed and laud the leisur'd mole,

. . . . . .

The world moves yet but fleeter to its goal.

CHAPTER XI

RAPID TRANSIT IN THE TWENTIETH CENTURY

The opening years of the twentieth century were remarkable not so much for the development of new modes of transit, but for the improvement of those already in use with the aim of increased efficiency. In transportation problems, as in other branches of engineering, economic considerations enter very largely, so that even though time of travel between places is reduced, unless it can be performed economically and there is adequate demand for such service, no ultimate end is gained and the improved speed stands merely as a record devoid of useful application.

In no department of transportation has the matter of speed been of more vital interest than in the case of the trans-Atlantic steamship. From the days of the *Britannia* with her modest average speed of 8.5 knots per hour in 1840, to the *Deutschland*, with an average speed of 23.5 knots per hour in 1902, the development of power and speed has been marked. The cutting down of the time of ocean passage has been accompanied by increased travel, so that every effort on the part of the great steamship companies to secure fast voyages is met with support and approval. The quadruple expansion engine and twin screws were constantly improved in efficiency so that by 1903 the record of the *Deutschland* of five days, eleven hours,

fifty-four minutes from Cherbourg to New York represented about the best performance of the reciprocating engine. In other words, the limit was set for this form of engine in driving a ship through the water at high speed with any approximation to economy, for it must be borne in mind that a slight increase in speed means considerable increase in power, and this can be obtained only by a disproportionate consumption of fuel which after a certain point becomes impossible. It was on this account that marine engineers realized that were further developments in speed to take place, some new form of prime mover must be sought.

In 1903 a record was made for vessels with reciprocating engines when the *Kaiser Wilhelm II.*, 706 feet long, and 27,000 tons displacement, with engines of 40,000 indicated horse-power, was put in service and crossed the ocean at an average speed of over 23½ knots. The *Kronprinzessin Cecilie* has a record of five days, eight hours, and seven minutes for the 2,962-mile run from New York to Plymouth, made in 1908.

In modern engineering the success of the steam turbine in the case of torpedo boats and small ships such as the *Turbinia* (1897) and *Viper* gradually led to its consideration for use on larger vessels. The *King Edward*, put into service on the Clyde in 1902, was the first application of the turbine principle to a passenger steamship, and while but a small river-craft, demonstrated its usefulness and economy, securing increased speed with a saving in coal of 15 per cent. British builders then constructed

turbine vessels for trans-Channel service, and it was found that increased freedom from vibration as well as economy resulted. Notable among these vessels was the *Queen,* which made the twenty-two miles from Dover to Calais in less than an hour. The *Queen* was but a beginning for various British and Irish channel steamers. These ships, some of which were put in service in 1904, then led the way for cruiser construction with turbine engines by the British Government and several small vessels were laid down, which, of similar design, were to contain in some instances turbines, and in others the ordinary reciprocating engines. Thus the British cruiser *Amethyst*, of 3,000 tons and 360 feet in length with turbines, was able to make 23.63 knots as compared with 22.1 for the *Topaz*, supplied with reciprocating engines, with a much smaller coal consumption per horse-power. When these ships were tested, the superiority of the turbine was demonstrated again, and its adaptability for still larger steamers seemed assured. A ship for the Australian trade, the *Loongana*, was put in service in 1904, and was followed in 1905 by two liners of the Allan Line, the *Virginian* and *Victorian*, each 520 feet long, designed to run between Liverpool and Montreal at a speed of 16-17 knots. These ships, too, succeeded in reducing the time of passage with the same or less coal consumption, and, finally, the Cunard Company laid down four large vessels, but one of which, the *Caronia*, had reciprocating engines. Her sister ship, the *Carmania,* put into service in 1906, a vessel of 30,000 tons and 672 feet in length, was fitted with turbine

engines of 20,000 indicated horse-power, and proved one knot faster.

The *Lusitania* and *Mauretania*, added to the Cunard fleet in 1907, and whose construction was made possible largely through government subsidy, were supplied with turbines of 70,000 indicated horse-power. These great vessels, 45,000 tons displacement and 790 feet in length on the deck, represented the largest vessels ever launched. It was found for large ships of this class that the turbine would work effectively and economically, driving them through the sea at the required speed, both vessels being able to maintain an average of over 25 knots per hour, while on the trial trip a speed of 29 knots was obtained. Immediately there began a reduction of time for the trans-Atlantic passage, and on successive voyages record after record was made. This reached an apparent culmination when the *Mauretania*, in 1909, on her first eastern voyage, where a stop was made at Fishguard, on the coast of South Wales, to land London passengers and mails, made a record voyage from Sandy Hook to Queenstown of four days, fourteen hours, and twenty-seven minutes, August 25-30, 1909. More practical perhaps is the statement that the trip from the pier in New York to the station platform at London was made in five days, nine hours, and twenty-two minutes, of which five hours must be subtracted for the difference in time of the two cities, this being rendered possible by train service on the Great Western Line, which made the run of 262 miles up to London in four hours and thirty-two minutes. Nor was this all, for it reduced ma-

terially the time between New York and Paris, so that a traveler breakfasting in New York of a Wednesday could breakfast in Paris on the following Tuesday. The success of the new Fishguard port of call was considered as indicating the probability of more direct connections with the Channel steamers for the Continent.

Not to be behind her sister ship, the following week the *Lusitania*, steaming at an average rate of 25.88 knots with much of it at over 26 knots, made the run from Queenstown to Sandy Hook of four days, eleven hours, forty-two minutes, thus breaking the best record of the *Mauretania* for the westward passage, so that for the first time the Cunard Line sailing from Liverpool on Saturday landed its passengers in New York on Thursday evening. On the next passage westward the *Mauretania* regained the record, reducing the time by seven minutes, and on the westward trip, ending September 30th, made the trip in four days, ten hours, and fifty-one minutes, despite two days of rough weather. The average speed on this trip, 26.06 miles, also marked a new record.

In the meantime, the British Government had provided for battleships of immense size with turbine engines. The first of these, the *Dreadnought,* was launched, and, great floating castle as she was, was driven through the waves at a rate of speed far in excess of that ever before attained by any vessel mounting anything like the number of guns. In the United States three scout cruisers of almost identical design were built, two of which contained different types of turbine, while the third was given the recipro-

cating engines. The supremacy of the turbines was again demonstrated by the speed records. But not for all purposes was the turbine found economical. At high speeds it answered admirably, but at low speeds was lacking in efficiency, so that to secure all the desired elements several ships designed in 1908 were constructed with a combination of turbines and reciprocating engines. Thus the *Olympic* and *Titanic,* under construction at Belfast in 1910 for the White Star Line, contained reciprocating engines to drive the outside propellers and turbines working on the inner pair, while a low-pressure turbine, operated by the exhaust from the reciprocating engines, was used to drive a shaft on the centre line of the ship.

The speed of torpedo boats by the use of turbine engines continued to increase, and in 1909 the torpedo boats had attained a speed of nearly 36 knots as in the case of the British torpedo boat *Swift.* In the United States Navy the fastest torpedo boat destroyers are the *Flusser* and the *Reid,* which in 1909 made 33.7 knots and 34.548 knots respectively. These boats are smaller than the *Swift*, being of 700 tons as compared with 1,800. In some navies, especially the British, there was a reaction from extreme speeds, and larger and more powerful destroyers were demanded. The new torpedo boats designed in 1907 were given a speed of 27 knots as compared with 30 for those previously constructed. Thirty knots, however, seemed to be the speed deemed essential in the German Navy.

A new method of propulsion in recent years has been under consideration and by many en-

gineers is considered to be the motive power of the future. The great success that had attended the use of internal-combustion engines on small craft and in large units on land led to the question, why could not gas engines be installed on vessels where the coal, instead of being burned under boilers, would be transformed by a producer into gas and then used as fuel in gas engines. The economy of such a step seemed obvious. The amount of space required for propelling machinery would be reduced considerably, the weight of water carried for the boilers would be eliminated, and there would be fewer stokers and machinists required to operate the engines. Furthermore, there would be no smoke given off and it would be possible to employ cheaper grades of fuel, as these would supply the necessary gas satisfactorily. The first work of this kind was that of Herr Capitaine in Germany, and he constructed barges in which this principle was introduced. A few years later a small British gunboat, the *Rattler*, was equipped with a producer plant and a 5-cylinder single-action gas engine of 500 horse-power. While the installation was but experimental and high speed was not sought for, yet virtually the same speed as with reciprocating engines and considerable increase in economy were secured. Another unique installation containing a minimum amount of steel and iron was installed on the American non-magnetic yacht *Carnegie*, designed for magnetic surveys on the high seas, and launched in 1909. This was for auxiliary power, as the *Carnegie* was primarily a sailing craft, but it demonstrated the feasibility of the

gas engine when under restricted conditions, and several small yachts were constructed along similar lines. While the producer plant and engines on shipboard have not as yet supplied speed records, yet the idea and its application are quite in their infancy. The engineers interested are eager to try their hand at large and speedy vessels, and apparently there is no reason why the gas engine at sea should not reach the success it has on land.

But if the internal-combustion engine in large sizes is in a trial stage, smaller boats have long since passed from that condition. Not only is the engine that employs gasoline as a fuel essential to most sailing yachts and even to the dories of the fishermen, but special craft, either of high power for speed or arranged for cruising, are now equipped with these engines. The improvements which the construction of motor vehicles brought in gasoline engines have been applied in so-called power or motor boats where speeds up to 35.8 statute miles an hour have been obtained, and motor-boat racing is quite as much of a sport as automobile contests on land. The rather crude naphtha launch of a quarter of a century ago is now the trim power boat seen on every harbor or mountain lake whose convenience and speed are comparable to the motor vehicle on land, the engines of which, indeed, form the model in many cases.

Increase of speed in railway travel has resulted rather from the improvement of roadbed and track than the construction of more powerful locomotives. Practically a limit has been reached on the power of a locomotive designed

for high-speed passenger service, as the gauge of a track is a fixed and determined quantity which conditions the size of the machine that can be operated on it. With freight locomotives, articulation or the separation of different sets of driving wheels and the use of several sets of cylinders is possible, but with the express locomotives one set of drivers is all that can be used. Thus, while little improvement has been seen for the locomotives drawing the Empire State Express, the Pennsylvania Limited, and other fast trains, yet the standard of speed in American railway travel is constantly being raised, and the improvement of track, the straightening of the right of way, and the elimination of grades either by tunnels, re-location, or other means has produced better and satisfactory service. This, of course, answers for economy of operation, but more distinctly in the case of improved speed, and as a result of improvements which had been taking place for several years in the roadbeds of the transcontinental lines, in 1909 important reductions of speed were announced. Thus, on the Great Northern system a reduction of the running time between Chicago and Seattle from seventy-two to sixty-two hours was announced, with a fast mail service direct between Chicago and Puget Sound. This train makes the 1,814 miles between St. Paul and Seattle in forty-eight hours, or an average rate of speed of 37.7 miles an hour, which is eleven hours better than previous records.

During the autumn of 1909 the running time between Chicago and Denver was also reduced on several railways by two hours, and a beginning of

speed contests on the part of the various transcontinental lines from Chicago to the Pacific Coast was promised. Improvements in the Union Pacific and the construction of the new St. Paul line according to the most modern methods of railroading made it possible that as good, if not better, speeds than on the Great Northern and Burlington could be maintained. Other fast trains introduced in 1909 were the twenty-four-hour fliers between New York and St. Louis on the Pennsylvania Railroad, which reduced the time between the two cities by three and a half hours. In addition to the transportation of passengers, the road supplying the fastest and most regular service receives the mail-carrying contract from the government, and this in itself, apart from its value as an advertisement, is an important consideration. With improvement in speed there has been no backward step in taking care of the comfort of the passengers. Wooden cars are giving place to those of iron and steel with a minimum of combustible material, while such conveniences as baths, and telephones for connection at stations are supplied, in addition to such older features as stenographers, maids, valets, libraries, and observation platforms, now deemed essential on all through express trains.

The famous speed of the Empire State Express is now rivaled by the Pennsylvania Limited, which has made the trip from New York to Chicago (897 miles) in sixteen hours, three minutes, and by the Twentieth Century Limited, which has covered the distance of 960.52 miles in fifteen hours, fifty-six minutes. This last-

named train, with an average of nine cars in its east-bound journey from Chicago to New York, was run in 1909 from February 17th to June 20th, or 123 consecutive days with only ten minutes aggregate delay. A general increase of speed rather than rapid or phenomenal runs and increased care in operation, brought about in part by government legislation, has been a feature of American railway travel in the last decade. In Europe high speeds are also maintained, though less improvement in this respect is to be noted than in the United States. On the Munich-Augsburg line a compound express locomotive has hauled a 150-ton train at a mean speed of 80.8 miles per hour, and maintained during a considerable part of the run a speed of 96 miles per hour. Then again the long journey from London to Yokohama by rail has been reduced to 15 days *via* the Siberian Railway, with the time from Moscow to Irkutsk 150 hours, and on the westward trip 129 hours.

The coming of a general electrification of railway lines has been slow, but it has found application in numerous important instances, particularly at the terminal in large cities, where the smoke and noise of steam locomotive had developed to a point where they were positively objectionable. In New York City, for example, the New York Central and Hudson River Railroad for several years has entered the city after changing from steam to electric locomotives, and its electric zone has been constantly extended. The New York, New Haven & Hartford Railroad, using the same terminal, also employs electricity, using the direct current of the New York

Central system so long as it employs the latter's tracks, and then changing to alternating current which is transformed within its locomotives. This railroad maintains a satisfactory electric service between New York City and Stamford, where steam locomotives are coupled on to the trains for the journey through New England. On the Long Island Railroad a beginning of electrification was made in 1907, and this has been gradually extended with considerable success for its suburban service. But the most extensive plan is that of the Pennsylvania Railroad at its New York terminal, where tunnels from Long Island City under the East River and the heart of Manhattan to its great terminal station and then under the Hudson to New Jersey are to be operated entirely by electricity, with the likelihood that the limits may be extended even to such a distance as Philadelphia.

When traffic is congested, as at a terminal or in suburban service, electric working increases the capacity of the tracks by as much as 50 per cent. It has been estimated in the case of the Boston terminal that it would make possible cutting the three-minute headway of steam working to two minutes.

On the Pacific Coast the heavy grades have long given trouble to railroads, and extra engines are often required to pull or push the heavy expresses over the mountains. It has been decided in the case of several lines to utilize the water power of the mountains for electric locomotives and use them on mountain service with a manifest saving of coal and the increase of comfort to the passenger where tunnels are involved.

The electric locomotive as developed by the General Electric Company and the American Locomotive Company has made speeds up to ninety miles an hour, on an experimental track and has met every condition of service. Using direct current supplied from a third rail at the side of the track it has been used extensively, while single phase or polyphase lines where alternating current is transformed at the motor have had considerable application, especially in Europe, when certain extraordinarily high speeds have been made under favorable experimental conditions.

The electric railway as an accomplished fact, however, is seen to its best advantage in urban and interurban lines which, in many cases, operating on their own right of way, furnish a means of communication between towns and cities that the steam railroad is unable to compete with. The steam locomotive with its train is rather a heavy combination and requires considerable power; consequently, a train cannot be run as frequently as the convenience of a community might demand. On the other hand, electric cars are smaller units, requiring fewer operatives, and where they have their own right of way or on protected highways can maintain a speed little less than that of a steam line. An important gain is the shorter time consumed in accelerating to full speed from a stop and *vice versa.* The electric cars can offer a schedule far more liberal in the matter of trains than the steam railroad, and as a result of coöperation and inter-connection they now cover much of the territory of the United States, passing by

farm and factory and bringing the town into close connection with the country. In some cases a system sufficiently extended to warrant the operation of sleeping-cars can be noted, while everywhere country previously inaccessible has been developed and rendered available for workingmen's dwellings. The extent of electric lines can be appreciated by the fact that it is possible to make a continuous journey from New York City to Chicago by using the local electric lines. Such a journey has been made in three days and twenty-one hours, or forty-five hours and twenty-four minutes of actual running time, at an expenditure for fares of $19.67.

The importance of the electric railway is demonstrated by the fact that in Massachusetts the street railways have more mileage than the steam roads and carry four times as many passengers. Furthermore, they run three times as many car miles as the latter do train miles and carry nearly twice as many passengers, while their incomes are about three quarters as large.

The rapid-transit problem of the twentieth century is found at its most acute state in the large cities. Practically nowhere are the transportation facilities adequate, and while there may be little complaint as to the quality of existing facilities, yet everywhere is their inadequacy deplored and a clamor rises for more accommodations. For thickly settled communities it has been found that the underground line with electric motor cars presents the only satisfactory solution of the difficulty, and particularly this is the case of many cities surrounded or bordered by navigable rivers which must be

crossed to afford transportation to and from the outlying districts. Overhead trolley or conduit lines answer where there is no great congestion of traffic or where their noise is unobjectionable to the residents. But their necessary limitation, due to operating in streets more or less crowded or where care has to be taken to avoid accidents to other users of the streets, make it manifestly impossible for high speed to be maintained, therefore everywhere, in London, Paris, New York, Philadelphia, Boston, and Chicago, more underground roads are either strenuously demanded or are in course of construction, and it is found that they can be constructed with a minimum of disturbance to streets. The transit problem is one of complexity and enormous size. Where private ownership is involved it is obvious that the provision of adequate facilities must lag long behind their actual need, as capital must be satisfied that the initial outlay will be well remunerated in dividends. Where municipal ownership or operation is involved various political and economic questions come to the front, as is also the case where the two are combined. As a result, all large cities, especially those in America, are deficient in adequate transit facilities, and the problem has passed from the engineering to the economic stage.

Thus, in addition to its subway system, New York has communication with New Jersey by the tunnels of the Hudson and Manhattan company, which with nine miles of double track and two sets of tunnels under the Hudson River, bring the heart of the metropolis in connection with the New Jersey railway terminals in Jersey

City and Hoboken. The second set of tubes was opened on July 19, 1909, and the enterprise represents a capitalization of nearly $70,000,000.

In connection with the problems of urban transportation, the elevated railroad is now regarded as a useful but temporary makeshift and destined to be supplanted by subways. Yet the elevated railway or viaduct is found particularly useful where the ground is uneven and for building up the territory where a high-speed service is demanded.

Not only is transportation of passengers an important item, but also the proper distribution of merchandise. With the growth of large cities the freight terminals are at considerable distance from the warehouses and distributing centres, and at the best freight undergoes a costly process of lighterage and transportation on trucks which does not harmonize with twentieth-century methods of doing business. The motor truck is but a partial solution of the difficulty, and in Chicago some small tunnels and subways primarily constructed for telephone and electric cables are now employed for the collection and distribution of freight in the mercantile districts and its transport to and from the various freight stations. This plan has worked with considerable success and has called attention to the needs existing in many large cities of a system of subways whereby merchandise could be loaded directly to or from freight cars in the cellar of the warehouse, and then the cars taken to various classification yards, where they could be made into trains for the various railways. Indeed, such a scheme is contemplated for New

York City, but its realization, however much needed, is a matter of future development.

The monorail system has been set forth by many inventors as affording a satisfactory means of high-speed rapid transit. Models that demonstrate its possibilities have been constructed, and in the Brennan system a gyroscope car has been tested on a reduced scale with some degree of success. Yet, despite elaborate plans and calculations, there have been few practical realizations of this idea, though a line was under construction in 1909 in one of the suburbs of New York City.

No single agency has done more to develop rapid transit both for pleasure and for business than the motor vehicle. The familiar automobile can almost compete with the steam railway in point of speed, and on smooth roads, unhampered by or in defiance of legal restrictions, speeds of sixty and seventy miles an hour are obtained. The track and road racing records, one by one have been supplanted with such rapidity that motor racing has become a special sport, fostered rather by the manufacturers of cars for purposes of advertisement than supported in the interest of car users and sportsmen generally. In many cases a high-powered racing automobile has developed into a freak machine which serves no useful end save that of sport, and the deaths and injuries that have followed racing have produced general popular disfavor with this form of amusement. Nevertheless, large motor tracks for both long and short distance racing have been constructed, where races are held from time to time. Road

races also take place under special conditions to show reliability or durability and are more valuable tests of the machines.

But it is in its useful and ordinary application that the motor car has reached its present high point of usefulness. The improvement of materials, especially of steels of unusual strength, the gradual development of reliable machines, and the policy of standardization have resulted in cars which, from the mechanical point of view, leave little to be desired, and in actual use have proved eminently satisfactory. The American builders of motor cars have followed European models, not slavishly, but imitating only the best features, and at the same time have made improvements which different conditions of highways and service have rendered necessary. A number of large manufacturers have completely standardized the process of manufacturing, and as a result machines are turned out in large numbers with complete interchangeability of parts. Each part must be built of tested material according to standard specifications and size, and when assembled the machine is efficient and of a high order of workmanship. Furthermore, this policy makes possible a constant reduction in price, and as the industry increases in size, the moderate priced motor car is brought more and more within the means of an increased number of users.

The speed of the motor car not only makes it a pleasure vehicle, but also valuable from a business point of view. Thus a farmer is able to go to the village for supplies or other errands with a minimum loss of time from his farm and

without involving any fatigue to horses that are required for farm duties. A contractor is able to supervise a larger amount of work than he could by horse and wagon, while even in the logging districts of the West motor cars are employed extensively by superintendents overseeing the operations. A notable instance of the use of a high-speed motor car is that of the chief of the New York Fire Department, who, in a high-powered car, capable ordinarily of a speed of a mile a minute, within half or three quarters of an hour at the very outside can be at the scene of any fire in the Greater City.

The developments of the motor car have been careful improvements in its construction rather than any radical departure from previous ideas. The strength of parts and economy of operation have been prime essentials.

The availability of the automobile vehicle for transportation of merchandise as well as of passengers has been seen, and the tire troubles which once threatened very seriously to limit the use of automobiles are being in part solved. High-powered vehicles of considerable capacity have been found more economical than horses and are available for constant operation. All of the leading armies of the world now maintain automobile trains for their supplies, and they have proved wonderfully effective where roads would permit their use.

The motor cycle has taken the place of the bicycle among certain classes, and in addition to its function as a pleasure vehicle is used by mechanics in going to and from their work in country districts, and even by missionaries with

large territory for pastoral visitation, as in the Great West. A motor cycle built by Glenn H. Curtiss, the famous aeroplane designer and aviator, succeeded in making a mile in $26\frac{2}{5}$ seconds on the motor track at Ormonde, though the machine was ruined in the operation.

The twentieth-century problem par excellence is navigation of the air, and its solution has been rendered possible largely by the development of the light-weight, high-powered gasoline motor to drive powerful propellers. These motors for automobiles and power boats have been brought to a high degree of efficiency. It was impossible for the earlier aeronauts and aviators to secure power without undue weight of engines, but that is now very simple. The balloon that for many years was at the mercy of the aerial winds and currents, before the close of the nineteenth century had become a dirigible airship, and little more than fifteen years after Santos Dumont's memorable trip where he circled the Eiffel Tower, the continental armies were provided with balloon battalions, equipped with dirigibles of more than tried merit. The Le Baudy airships of the French Army, the Gross and Parseval of the German, and the great Zeppelin airship have found extensive use in military maneuvers and in trials to demonstrate their practicability. In the huge machine of Count Zeppelin, consisting of a number of balloons or cells united together and carrying a large gondola containing crew and machinery, a trip of 270 miles, from Friedrichshafen to Bitterfield on the way to Berlin, was made in August, 1909, the airship being thirty-eight

hours in the air. On May 31st and June 1st of that year the Zeppelin made remarkable trips, remaining in the air for thirty-seven hours and traversing a distance of 800 miles. Various dirigibles are in use, and where the winds are not too strong they are speedily and readily operated. Thus, in 1906-7 and 1909, Walter Wellman attempted a voyage to the North Pole from one of the Spitzbergen Islands, but without success. Yet, apparently, there seemed to be no reason why the North Pole should not be reached in this way much more conveniently than by sledge, as only about 300 miles must be traversed, and a dirigible would be able to carry not only sufficient fuel, but two or more men and scientific instruments. At an important aviation meeting held at Rheims in August, 1909, one of the fastest dirigible balloons in the French Army required 17 minutes and 57 seconds to traverse a lap of the course, which Bleriot in his monoplane passed over in 7 minutes, $47\frac{4}{5}$ seconds, or at a speed of forty-eight miles per hour.

The aeroplane may be said to date from the first successful experiments of Orville and Wilbur Wright made in December, 1903. In these the possibility of mechanical flight was practically demonstrated, and these two ingenious inventors from that time have worked assiduously to perfect their machines. Speed was increased and distance and time of flight were extended, and finally, in the spring of 1909, the brothers were able to satisfy conditions of the Signal Corps of the United States Army, which when announced a year or so previously were all but universally condemned for their excessive rigor.

Yet so rapid was their progress that it is probable that at the time of the final test of the Wright Brothers' machine that there were either in existence or nearing completion possibly half a dozen types of machines that could have complied with the specifications of the government tests. For by that time an aeroplane had been developed which not only could maintain flight over a given period of time at high speed, but could be maneuvered at will and be practically available for military work. On July 25, 1909, occurred an epoch-making event in the passage of the British Channel from Calais to Dover by M. Bleriot in his aeroplane, this truly remarkable accomplishment coming as it did after an unsuccessful attempt by M. Latham, in which his machine failed after more than half of the passage had been made, and necessitated his rescue by the French torpedo boat accompanying him. M. Bleriot is entitled to the greatest credit for this achievement, yet it must be remembered that several other aviators with their machines were quite ready to make the trial. It was proved, however, that an aeroplane could be operated on a practical basis over long distances, and at once the possibility of such an invasion of Great Britain was discussed in the European press. Even more notable than M. Bleriot's accomplishment as indicating the progress of the use of mechanical flight with machines heavier than air, was an exhibition and competition held at Rheims in August of the same year. Here numerous aeroplanes were seen maneuvering in the air at once and in active competition. In fact, it was said at the time that this meeting

indicated distinctly the coming of the aeroplane into its own as a means of locomotion, for here were assembled machines of various inventors and manufacturers, fashioned perhaps on similar principles, but differing in detail, and the greater part of them demonstrated their complete practicability.

Thus in the first competition for the International Cup of Aviation, given for the fastest aerial journey of 20 kilometers (12.42 miles), there were four contestants, all of whom had successful aeroplanes and went over the course without mishap. The prize was won by the American aeroplane of Glenn H. Curtiss, going over the distance in 15 minutes, 50 $\frac{3}{5}$ seconds, while the fourth aeroplane required 20 minutes, 47$\frac{2}{5}$ seconds for the same distance. In a competition over a distance of 30 kilometers, ten contestants competed, and again the American aeroplane won with a record of 23 minutes and 29 seconds, exclusive of penalties. That the aeroplane is able to reach considerable altitude as well as to fly low along the surface of the ground was proved by the fact that a height of 490 feet was attained and at this height that complete control of the aeroplane was maintained.

This first general meeting of aeroplanes brought together a number of types which permitted comparison to be made. That of the winner, Curtiss, was a biplane, following in many respects the characteristics of the Wright aeroplane. There were also monoplanes as those of M. Bleriot and M. Latham, which made good records, so that these two leading types

promised to compete for popular favor. That the aeroplane can accomplish more than short distances was demonstrated at Rheims by flights of seventy-two and ninety-six miles and in several cases the aviators were compelled to return to the ground as they had neglected to carry sufficient gasoline with them for their motors. The aeroplane has been successful in carrying one passenger besides the aviator, and in fact this was the condition imposed by the United States Army when the Wright machine was submitted for trial. The future of the art of aviation doubtless lies quite as much in the training of the individual operators of the machines and their knowledge of all practical conditions of working as well as the finer points of the construction of the machine as in any radical improvements. For carrying dispatches, and reconnaissance, the aeroplane to-day has a distinct military application, while after the Rheims competition, the possibilities of long distance work, and such trips as across the Atlantic Ocean were not considered as impossible at some future time.

In no field of rapid transit does the public manifest greater interest than in the transportation of the mails, and, consequently, governments are eager to avail themselves of mechanical and other improvements which reduce the speed of transmission between places. Thus, no sooner is an ocean record made by a steamship than the post-office authorities are anxious to employ the line making it to handle the mails, and not only that, but at the ends of the voyage every effort is made to reduce the time consumed in handling and docking. Thus, in 1909,

a saving was effected in Great Britain by transporting the American mails from London to Fishguard on the coast of Wales, where they were transferred to the Cunard steamers on their way to Queenstown, and at the same time at the American end extra post-office boats were placed in service, so that mail for Western cities could be carried direct to the railway piers, obviating any re-sorting in the New York Post Office. Previously the sorting of mail in transit between the two countries had been practised for some years, and this, too, effected an important saving of time. In the railway-mail service better organization and quicker collections are constantly secured and use is made of trolley lines for distributing mail promptly in suburban towns and through villages. The automobile wagon for collecting mails and sorting them en route is employed for large cities, and for rural free delivery the motor cycle or automobile has cut down the time of the horse and wagon or other means employed by the carrier. In the cities the increased use of pneumatic tubes has also been found serviceable both for handling mail and for dispatching telegrams from branch stations to a central point, and it was proposed in New York to install a pneumatic system between the Customs House and the Appraisers Stores to handle promptly the large mass of communications passing between these two government establishments, just as is the case between different departments of a large business under the same roof.

With the development of civilization the transmission of intelligence has always been a

primary consideration and the telegraph properly has been considered one of the greatest boons to man. Despite the various systems of wireless there has been no diminution in use of the older methods, and telegraphy over wire conductors flourishes quite as well as before the days of Marconi. While the speed of the actual transmission of signals cannot enter into the question, yet the quantity or the number of messages transmitted over a single wire is an important item, and the developments of the twentieth century show automatic transmission where the messages are sent at great speed over a single line, and in fact a number over such a line by automatic methods where a tape is punched by a number of operators using machines but little different from typewriters. Long distance transmission of messages automatically is undertaken and is maintained between England and India. Thus, in 1909, there was direct working between London and Karachi and Calcutta, India, *via* Teheran, or a distance of 5,874 miles. On this line thirteen automatic relays were inserted and messages were sent out.

Recent years have seen the development of a new era, and the cross-channel work of Marconi in 1899 has developed to a point where trans-Atlantic wireless communication is an every day matter and press dispatches across the ocean are handled with facility. Furthermore, every steamship carrying wireless equipment is in communication over a large radius with vessels similarly equipped and in many cases has rendered assistance to mariners and

passengers in peril. A vessel from New York to Liverpool is now constantly in communication with one shore or the other as well as with other ships en route, and it is stated that on the North Atlantic a ship with the Marconi system communicates on an average in a day with four vessels similarly equipped. It is recorded that the wireless station on the Eiffel Tower is able to take up messages originating in America.

The twentieth-century telephone, no longer a luxury but a necessity, has linked up outlying districts with populated centres, as well as furnished a complete means of intercommunication in the large cities and towns. The growth of the use of the telephones, especially in the United States, has been phenomenal, so that one telephone is now maintained for every seventeen inhabitants. The switchboards maintained in great cities accommodate thousands of subscribers and are marvels of intricacy and telephone engineering, while in the rural districts farmers' telephone exchanges are maintained, varying all the way from standard equipment with poles and wires to the use of fence wires for the line. Telephonic communication between such distant points as New York and Denver is maintained, while for intermediate distances the service is so efficient as to become almost commonplace. Better conductors and improved instruments make possible this long distance transmission, while the difficulties once experienced where wires were carried underground are now obviated by the use of inductance coils placed at regular intervals, according to a system devised by M. I. Pupin. Thus an underground line between

New York and Philadelphia is independent of weather conditions, such as sleet or snow storms, and furnishes good service. Where it is desired to cross large bodies of water the same device is practicable and has been applied in Europe.

Most interesting of its developments, perhaps, is the automatic telephone exchange, where the subscriber by merely moving an indicator on a dial is able to connect himself with any other subscriber without the intervention of the switchboard operator. This system has found application in a number of Western cities in the United States, particularly on independent lines outside of the control of the large companies controlling the bulk of the business. In the ordinary telephone in most cities the old magneto and battery have been supplanted by central energy systems, where the storage battery at a central station is the source of the electrical energy. Not only does the telephone furnish communication over long distances, but intercommunication between various points in the same building and the distribution of traffic is carried on in the same way as on the larger lines, even in dwelling houses where instruments are installed communicating one with another.

In our consideration of various systems of rapid transit some attention must be given to the problem of vertical transportation. As great cities have increased, in order to secure the concentration necessary for the proper conduct of business, huge office buildings or skyscrapers have been erected, in some cases reaching to thirty, forty, or more stories in the air. To gain access to the upper, or, in fact, to any of the

floors of modern buildings, the transportation of people in elevators must be carried on and the problem is no less serious than in horizontal transportation. In fact, in the city of New York over twice as many people travel in elevators during the day as ride in all the various rapid-transit systems, and the office on the thirty-eighth floor must be made as accessible as the one on the third or fourth. In some buildings, notably the Hudson Terminal, the tenants and their employees may aggregate over 10,000, and the volume of traffic on the elevator system in such a building is easily comparable with that of a suburban trolley line, although the distances, of course, are immeasurably shorter. The cars in such a building run between twenty and thirty miles a day, and at speeds up to 600 feet a minute for express service, so that within a minute or a minute and a half from the time he leaves the ground, the passenger must be landed on any floor, else the offices are less desirable for tenants than those in buildings where quick and efficient service is maintained. Thus the journey to the fortieth story requires hardly as much time as to the seventh or eighth a quarter of a century ago, and at the Metropolitan Life Insurance Tower in New York City, completed in 1909, the 586 feet of travel to the forty-fourth story can be accomplished in but a few seconds more than a minute, while five other elevators serve the floors from the tenth up to and including the forty-first. For this high-speed travel over various distances, several forms of elevator are available. In the Metropolitan Life Insurance Company Tower in New York City, the

highest office building in the world, and the highest single structure with the exception of the Eiffel Tower in Paris, the electric traction elevator is employed where a car is moved up and down in a shaft by a cable, which is passed around a driving pulley or sheave and connected with a counterweight. In buildings somewhat lower, yet still of considerable height, the car may be mounted on the end of a plunger working in a hydraulic cylinder sunk in the ground. In addition various other forms of electric and hydraulic machinery may be employed.

The elevator presents its problems of transit no less than other modes of conveyance and its satisfactory operation requires quite as much attention. Thus, in addition to maintaining its safety, its regularity and speed of operation must be observed, and no congestion or overcrowding suffered, as such would interfere with the regular circulation of people using the system. In modern installation a telephone at the operator's ear enables the chief engineer of the building and the elevator starter to supervise the running of the cars.

Thus, in all problems of transportation and the transmission of intelligence by electrical or mechanical devices, the chief aim is to cut down the time consumed and to derive efficient and economical methods. Whether it be airship or tunnel a successful invention at once finds wide application. Rapid transit to-day is one of the strongest agencies at work in solving many of the problems of twentieth-century civilization and at the same time extending its benefits to distant or isolated points. Just as the railway,

steamship, and telegraph have brought the nations of the world into close connection with one another, so telephone, electric cars, and improved postal facilities are doing the same for individuals, raising the standards and ideals of the people of a single nation by putting them in active touch with each other for the freer exchange of commerce and ideas, where once this was physically impossible. So generally is this realized that he who invents, improves, or provides new means of rapid transit in the twentieth century is hailed as a great benefactor to his fellows and an active instrument in raising the standards of civilization.

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